Kansas Integrated Water Quality Assessment 2012

March 30, 2012

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EXECUTIVE SUMMARY

This report, the Kansas Integrated Water Quality Assessment (2012), was prepared by the Kansas Department of Health and Environment (KDHE) in response to water quality reporting requirements contained in sections 303(d), 305(b), and 314(a) of the federal Clean Water Act (CWA). Section 303(d) calls for the development of a list of waterbodies currently failing to meet established water quality standards, whereas sections 305(b) and 314(a) require information concerning the overall status of the state's surface waters and the programs responsible for water quality monitoring and pollution abatement.

The Kansas 2012 list of impaired waters (*i.e.,* 303(d) list) is included as an appendix to this report. This list is based primarily on data collected by the KDHE targeted surface water monitoring programs and secondarily on information obtained from outside sources. For this assessment, watersheds containing targeted stream chemistry and/or stream biological monitoring stations represented the assessment units for flowing waters. Monitored lakes and wetlands represented the assessment units for standing waterbodies. The Kansas 2012 303(d) list identifies 524 station/pollutant combinations of water quality impairment on lakes, wetlands and stream systems (watersheds), encompassing 2,610 stream segments, and needing the development of Total Maximum Daily Load plans (TMDLs) to address the offending pollutants. The 2012 list also identifies 403 station/pollutant combinations of waters that were previously cited as impaired in prior lists but are now meeting water quality standards, with 117 of these being new in 2012.

Requirements related to Section 305(b) were addressed, in part, using data obtained through a stream monitoring program implemented in 2006. This program employs a probabilistic survey design to estimate the stream mileage supporting those uses recognized in section 101(a) of the CWA: aquatic life support, food procurement, and contact recreation. The program's target population for monitoring and assessment included all classified streams that contained water during the summer low-flow periods of 2007-2010. Owing primarily to climate variation during this assessment window, only about 72% of the state's classified stream mileage was represented in the assessed population. Lake and wetland assessments for Section 305(b) as well as Section 314 reporting requirements were addressed using data from the targeted lake and wetland program, which uses a near-census approach in its monitoring.

Monitoring data obtained during this reporting cycle indicated that approximately 25% (± 4 %) of the state's designated stream mileage fully supported all three section 101(a) uses, whereas 75% (± 4 %) was impaired for one or more uses (parenthetical values represent 95% confidence intervals). Aquatic life support, contact recreation, and food procurement uses were supported, respectively, in 41% (± 3%), 81% (± 3%), and 59 % (± 6%) of the stream miles designated for these uses. Some major measures of non-support for streams, in order of prevalence, were aquatic macroinvertebrate community metrics, biological indicators of nutrient eutrophication, mercury in fish tissue, and *E. coli;* water chemistry parameters such as elevated metals or pesticides comprised a fifth category of causes. The most widespread discernible sources responsible for use impairments and/or pollutant loadings were agriculture (both livestock and crop production), followed by generalized anthropogenic influences (*e.g.,* erosion and sedimentation, atmospheric deposition of contaminants). Urban influences (both point and nonpoint sources) and other factors (including natural sources and weather-related impacts) were less widespread stressor categories.

Approximately 11% of the assessed lake acreage fully supported all designated uses, whereas 89% was impaired for one or more designated uses. Sixteen percent of assessed wetland acreage either fully supported all uses or lacked sufficient data to evaluate conditions; the remaining 84% was impaired for one or more designated uses. Major causes of impairment in lakes and wetlands included nutrient enrichment, siltation and turbidity, and zebra mussel (*Dreissena polymorpha*) infestations. Agriculture, municipal point sources, resuspension of sediments, and non-native species introductions were the primary sources of these impairments. Approximately 71% of the assessed lake acreage exhibited no recent change in trophic condition, 22% experienced a measurable deterioration in trophic state, and 4% exhibited some improvement in trophic condition (with 3% unknown).

Kansas experienced major statewide droughts in 2001-2006 and again in 2011. In 2007, major floods in southeastern Kansas scoured many rivers and creeks and produced sustained high stream flows for much of the summer. The combined effects of these dramatic weather-related events contributed to many of the water quality impairments documented in the past decade.

PART A: INTRODUCTION

Purpose

This document fulfills specific water quality reporting requirements placed on the State of Kansas by sections 303(d), 305(b), and 314(a) of the federal Clean Water Act. Sections 305(b) and 314(a) require a summary of the status of the state's surface waters. Section 303(d) calls for the development of a list of waterbodies currently failing to meet established water quality standards, which are regarded collectively as "impaired waters." Kansas is required under the CWA to take actions that improve the condition of impaired waters. These actions may include the development and implementation of TMDLs, water quality-based permit requirements, and/or nonpoint source (NPS) pollution control measures. This report presents an integrated response to the requirements of sections 303(d), 305(b), and 314(a). As such, it contains information relevant to upcoming water quality planning, monitoring, permitting, and pollution abatement initiatives in the state.

General Assessment Approach

KDHE administers several programs that collectively satisfy the environmental monitoring and reporting requirements of the CWA (KDHE, 2010e). These programs also provide the technical data needed to respond to existing and emerging water pollution problems. Departmental monitoring operations currently focus on the condition of the state's surface waters (rather than groundwater) and involve two different but complementary conceptual approaches. The first involves a targeted survey design that focuses on selected stream reaches, lakes, and wetlands. The second approach involves a probabilistic survey design that assesses randomly chosen stream reaches and extrapolates the monitoring results to the entire population of classified streams in the state. Targeted monitoring operations accommodate the development and refinement of the Kansas 303(d) list, whereas both targeted and probabilistic data are needed to meet section 305(b) and 314(a) reporting requirements.

Within KDHE, activities related to sections 305(b) and 314(a) of the CWA are performed by the Bureau of Environmental Field Services (BEFS), whereas work related to section 303(d) is performed by the Bureau of Water (BOW). Portions of this report addressing sections 305(b) and 314(a) characterize the overall condition of the state's streams, lakes, and wetlands and report on the prevalence of bioaccumulative contaminants in fish. They also describe the major monitoring networks and regulatory programs involved in the tracking, management, and abatement of surface water pollution. The 303(d) analysis differs from the 305(b) and 314(a) assessments in terms of statistical approach and monitoring period of interest. Moreover, under the provisions of the CWA, the 303(d) list is subjected to public review/comment approval by the U.S. Environmental Protection Agency (EPA).

Organization of Report

The remainder of this report is divided into several major parts. Part B contains background information on surface water resources within the state, describes the governmental programs primarily responsible for improving water quality, considers the overall costs and benefits of water pollution control, and summarizes several important water quality issues facing Kansas. Part C discusses the various water quality monitoring programs administered by KDHE, the diagnostic criteria and statistical methods employed in the 303(d) and 305(b) analyses, and the major findings stemming from these analyses. Part D summarizes the current status of groundwater quality monitoring efforts in Kansas. Finally, Part E describes the measures taken by KDHE to comply with the public participation provisions of the CWA, as related to the development of the 303(d) list. Technical appendices to this report provide additional information on KDHE's water quality monitoring programs and the results of the most recent assessments. Specifically, **Appendix A** identifies the individual water chemistry and fish tissue parameters considered in the 2012 305(b) assessment, and **Appendix B** presents the most recently completed 303(d) list for Kansas.

PART B. BACKGROUND

Total Waters

Table 1 shows a summary of the waters of the State of Kansas along with other geographic and demographic information.

Table 1. Geographic information on the total waters of Kansas

Topic	Value	Data Source
State population	2,853,118	U. S. Census Bureau, 2010 Census
State surface area in square miles	81,758.72	U. S. Census Bureau, 2010 Census
Number of major river basins	12	Dec 15, 2010 KSWR +
Total classified stream miles	27,738	Dec 15, 2010 KSWR +
Number of lakes, reservoirs, and ponds (publicly owned or accessible)++	317	Dec 15, 2010 KSWR +
Acres of lakes, reservoirs, and ponds (publicly owned or accessible)++	191,304	Dec 15, 2010 KSWR +
Acres of freshwater wetlands (publicly owned or accessible)++	55,969	Dec 15, 2010 KSWR +

+ The geometry of the Kansas Surface Water Register (KSWR) is derived from the 1:100,000 scale National Hydrography Dataset (NHD)
++ includes classified waterbodies as well as those pending formal acceptance of proposed classification

Water Pollution Control Program

I. POINT SOURCE POLLUTION CONTROL

The Kansas point source program was initiated in 1907 (K.S.A. 65-161 *et seq.*) and continues to be modified and expanded in response to ongoing amendments to the CWA. The federal regulations implementing this law are found in Title 40 of the Code of Federal Regulations. Federal water pollution control programs are designed to protect the navigable waters of the United States, whereas the Kansas water pollution control program is designed to protect all surface water and groundwater resources in the state by controlling discharges from municipal, federal, commercial, and industrial wastewater treatment facilities (WWTFs), permitted concentrated animal feeding operations (CAFOs), and urban stormwater.

KDHE is authorized to administer federal and state laws governing the treatment, re-use, and discharge of wastewaters in Kansas. Specifically, the department is responsible for the development and periodic review of water pollution control permits, the approval of engineering plans and specifications for WWTFs and sewage collection systems, the development of stormwater best management practices (BMPs), the establishment of pretreatment requirements for facilities in non-pretreatment program cities, and the performance of treatment plant compliance reviews. The department also oversees the development and management of operator training and certification programs in Kansas. Non-overflowing WWTFs are regulated through the Kansas Water Pollution Control permitting system (K.S.A. 65-165). National Pollutant

Discharge Elimination System (NPDES) permits are required for all discharging WWTFs, large and medium Municipal Separate Stormwater Sewer Systems (MS4s) and large agricultural facilities (**Table 2**). Agricultural facilities primarily include CAFOs but also include other animal feeding operations as well as some livestock markets and livestock truck washes. Wastewaters generated by these treatment facilities and operations are subject to technological effluent limitations, effluent guideline limits, and the Kansas surface water quality standards. Individual permits normally are issued for a period of five years, and all are reviewed by KDHE prior to re-issuance. The state's WWTF permit compliance record for calendar years 2010 and 2011 is summarized in **Table 3.**

In addition to regulating the wastewaters generated by these entities, the Kansas and federal programs have expanded into the area of stormwater pollution control. KDHE issues general permits for the control of stormwater runoff from construction and industrial sites, larger cities, and urbanized counties. Stormwater management plans have been implemented in 58 of the state's largest municipalities/counties/governmental entities and their surrounding areas to reduce the effects of stormwater runoff to their receiving streams. In addition, stormwater pollution prevention plans are required for construction activities disturbing more than one acre of land and for certain classes of industries that conduct activities in which materials are exposed to rainfall. Industrial facilities with individual permits are also required to develop and implement stormwater pollution control plans as part of their individual permit requirements. Stormwater NPDES permits are normally issued for a period of five years (**Table 2**).

Table 2. Number of active KWPC and NPDES permits as of January 1, 2012

Municipal and Commercial		Industrial and Federal +		Agricultural ++		Stormwater	
Mechanical Treatment Facilities (NPDES)	140	Industrial and Federal Discharging (NPDES)	528	Agricultural Federal (NPDES)	447	MS4 Municipal Stormwater (NPDES)	63
Discharging Lagoons (NPDES)	365						
Municipal and Commercial Non-discharging (KWPC)	411	Industrial and Federal Non-discharging (KWPC)	68	Agricultural State Permits (KWPC)	1361	Industrial Stormwater (NPDES)	1022
				Agricultural State Certificates (KWPC)	1602	Construction Stormwater (NPDES)	2487
Totals	*916*		*596*		*3410*		*3572*

KWPC = Kansas Water Pollution Control / NPDES = National Pollutant Discharge Elimination System
+ Tally does not include 59 industrial pretreatment facilities that discharge to municipal systems.
++ All agricultural facilities are nondischarging, but large facilities require Federal rather than State permits.

Table 3. Permit compliance record for discharging wastewater treatment facilities, 2010-2011

	Municipal and Commercial Facilities	Industrial and Federal Facilities
Total number of facilities	505	528
2010 absolute compliance+	91%	96%
2011 absolute compliance+	92%	97%

+ Absolute compliance means that a facility reported on all parameters specified in its NPDES permit and met all permit limits for the monitoring period (based on records submitted by the facility).

Over the past five years, a significant effort has been made to decrease nutrient (nitrogen and phosphorus) loadings to surface waters. In a document dated December 29, 2004, KDHE proposed and has since initiated a program whereby new and significantly upgraded mechanical wastewater treatment plants are required to construct and operate processes which will reduce the amount of nitrogen and phosphorus in the effluent discharges. As of January 1, 2012, over half of the mechanical wastewater treatment plants that generate significant amounts of nitrogen and/or phosphorus are either already operating such nutrient reduction processes or are in the process of constructing them. Additionally, a condition of renewing NPDES permits requires existing major facilities to assess the feasibility of retrofitting nutrient removal technology. Investments in such technology have reduced nutrient loads.

II. Nonpoint Source Pollution Control

Overview

Nonpoint source pollution refers to the transport of natural and man-made pollutants by rainfall or snowmelt moving over and through the land surface and entering lakes, rivers, streams, wetlands or groundwater. The Watershed Management Section administers CWA Section 319 funding and coordinating programs designed to eliminate or minimize NPS pollution. To accomplish this goal, the section develops and reviews strategies, management plans, local environmental protection plans, and county environmental codes intended to control NPS pollution.

The Watershed Restoration and Protection Strategy (WRAPS) program offers a framework that engages citizens and other stakeholders in a teamwork environment aimed at protecting and restoring Kansas watersheds by developing and implementing watershed plans. These projects are supported in part by the CWA 319 funds. Any public water supply system not covered by a WRAPS project is encouraged to complete a source water protection plan (SWPP). The Source Water Protection Program is available to assist any public water supply system with completing their plan. The Local Environmental Protection Program (LEPP) enables local authorities to develop water protection plans which are customized for their areas and that complement other water quality efforts being implemented by state and federal agencies.

Plans developed with LEPP funds describe actions that communities will take to manage private septic system wastewater treatment, solid waste, hazardous waste, NPS pollution, and private water wells. Finally, stormwater and NPS abatement projects, funded in conjunction with the KDHE Municipal Program under the American Recovery and Reinvestment Act (ARRA) of 2009, utilized $5.7 million to implement NPS/green infrastructure projects. Beginning in FFY10, approximately $2.6 million in Kansas Water Pollution Control Revolving Funds were allocated annually for Green Reserve Projects.

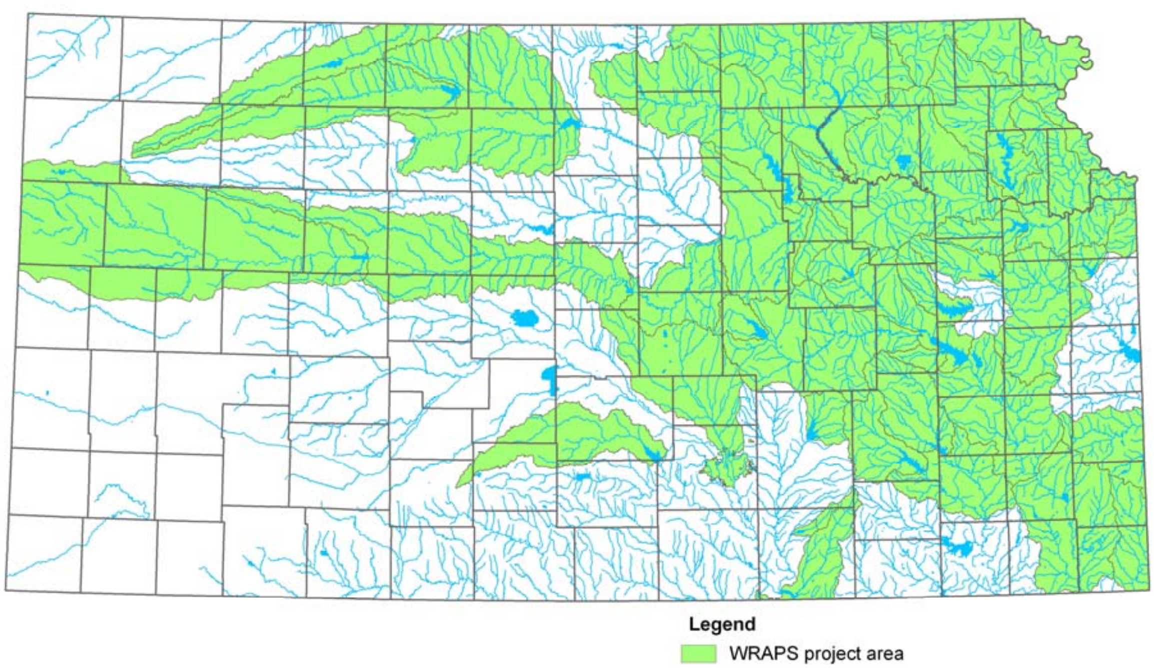
Watershed Restoration and Protection Strategy

Kansas has implemented a voluntary watershed-based program for controlling NPS pollution. Known as the Watershed Restoration and Protection Strategy (WRAPS), this program is unique because the natural resource agencies of Kansas, with support from the US Environmental Protectin Agency, aggressively seek citizen and stakeholder input and participation on watershed management and protection issues. This approach involves:

- Identifying watershed protection and restoration needs
- Establishing watershed protection and restoration goals
- Developing plans to achieve established goals
- Implementing fully developed plans

Watershed plans already implemented under WRAPS collectively serve and protect 48% of the state's total land surface (25,336,241 acres). This includes most watersheds draining into large federal reservoirs (**Figure 1**). Annual investments in WRAPS total approximately $2.7million (M). Of this amount, about $0.6 M is derived from State Water Plan funds and $2.1 M from CWA section 319 funds. Additional funds for Best Management Practices implementation come from programs of the Kansas Department of Agriculture's Division of Conservation as well as the Federal Farm Bill administered by the United States Department of Agriculture.

Figure 1. 2011 Kansas WRAPS Projects



Source Water Protection Program

The Source Water Protection Program is built on the principle that prevention often costs less than treatment. KDHE encourages public water supply systems and their surrounding communities to complete SWPPs on a voluntary basis and also partners with Kansas Rural Water Association to complete these plans. When the program was established, it worked with only groundwater based systems serving populations of 10,000 or less, but it has recently been expanded and is now able to assist both groundwater and surface water based systems serving any size population.

Source Water Assessments (SWAs) were completed for all active public water supply systems in 2004. States were required to complete their SWAs by June 30, 2004 as part of the 1996 amendments to the Safe Drinking Water Act. Funding for this program was provided by the USEPA, which provided grants to the LEPP participants to assist with completing the assessments. These assessments identified all potential sources of contamination for each public water supply system and serve as the basis for completing SWPPs.

The SWAs completed in 2004 are the first step in completing a comprehensive plan for protecting the public water supply system. Public water supply systems (PWSSs) and their surrounding communities use the SWA and the accompanying Susceptibility Analysis Scores to determine the contaminants and activities that pose the greatest threats to their water supply. On a statewide level, 54 percent of all PWSSs received a low (0-50 range) susceptibility score, 45 percent received a moderate (51-80) score, and only 1 percent received a high (81-100) score. Among the 12 major river basins in Kansas, the Lower Arkansas had the least percentage, 41 percent, of PWSs receiving low scores and the Verdigris had the highest percentage at 75. Results are presented in **Table 4.** These assessments are used as the basis for the action plan included in each source water protection document. Water quality protection measures or established Best Management Practices are assigned to address potential sources of contamination.

Table 4. Susceptibility analysis scores for public water supply systems in Kansas

	Susceptibility Scores		
	Low (%)	Medium (%)	High (%)
Groundwater supply system	54	45	1
Surface water supply system	51	43	6
By Population	*24*	*61*	*16*

Scores are taken from 2004 baseline Source Water Assessments

The State of Kansas currently has 1,021 active public water supply systems, and 237 of these systems have registered with the State to complete a SWPP. Of these 237, 113 currently benefit from an approved plan, and 86 of the 113 plans have been formally adopted by the participating communities (**Table 5**). Communities formally adopt their plan as a way to inform citizens in their community of the information contained in the plan and the importance of protecting their source of drinking water. SWPPs have been completed and approved for 108 groundwater-based public water supply systems and 5 systems that rely on surface water bodies to provide drinking water. Additionally, 63 public water supply systems relying on surface water sources (streams and/or reservoirs) directly benefit from NPS/WRAPS watershed projects.

Table 5. Public water supply systems benefiting from SWPPs and NPS/WRAPS Projects

Source Water Protection Plans			Nonpoint Source Watershed Projects	
Type	Number	Population served	Number	Population served
Registered	237	777,981	63	787,465
Approved	113	224,603		
Adopted	86	141,980		

Local Environmental Protection Program

The LEPP is administered by KDHE and was funded by the Kansas Water Office (KWO) under the auspices of the State Water Plan from SFY1990 through SFY2010. In SFY 2011, grant funds were allocated through the State General Fund. This program provides financial assistance to local governmental units developing and implementing environmental protection plans on behalf of their respective jurisdictions. All such plans include a sanitary code and address subdivision drinking water and wastewater treatment, solid and hazardous waste disposal, public water supply protection, and NPS pollution abatement. Currently, 104 of the 105 counties in Kansas participate in this program (**Table 6**).

Table 6. Summary of local environmental code actions through 2011

Status	**Number of counties**
Adopted and Being Administered	103
Approved for Adoption	1
Under Development	0
No Action	1
Total	*105*

Cost/Benefit Assessment

The direct and indirect costs of water pollution control can be measured, or at least estimated, with some degree of confidence. In contrast, environmental benefits stemming from pollution control are less amenable to expression in monetary terms. Section 101(a) of the CWA establishes national water quality objectives and interim goals reflecting the belief that the costs of water pollution control are outweighed by the ecological and social benefits of clean water. The following paragraph (and accompanying tables) address some of the major costs associated with water pollution control efforts in Kansas.

Pollution control expenditures in the state are associated predominantly with administrative expenses, capital investments, and operational costs for WWTFs. Although little information is available regarding the control costs borne by industrial and agricultural facilities, capital expenditures associated with the construction and upgrading of municipal WWTFs have been documented carefully by KDHE. For example, the department administers the KWPCRF, which provides low interest loans to municipalities for water pollution control projects. Available monies are maximized through the sale of “leveraged revenue bonds.” During the past twenty years, these bonds have provided $891 million for facility improvements in Kansas. KDHE also coordinates with the Community Development Block Grant (CDBG) program, which is administered by the Kansas Department of Commerce on behalf of the state. This program typically provides grant funding for about 50% of the costs of a selected water pollution control project. During 2010 and 2011, KWPCRF, CDBG, and other state and federal programs provided about $199 million in financial aid to communities in Kansas (**Table 7**). NPS pollution abatement measures received much less funding, relying instead on the predominantly voluntary measures and cost-share programs discussed previously.

Table 7. KDHE cooperative funding for construction and expansion of municipal wastewater treatment facilities

Funding year	KWPCRF +		CDBG +		RD +	
	Leveraged	Leveraged	Federal	Match	Federal	TOTAL
2010	$ 60.002 M	$ 69.438 M	$ 6.199 M	$ 7.988 M	$ 13.839 M	$ 157.466 M
2011	$ 17.000 M	$ 0.365 M	$ 3.495 M	$ 10.211 M	$ 10.233 M	$ 41.304 M
Total	$ 77.002 M	$ 69.803 M	$ 9.694 M	$ 18.199 M	$ 24.072 M	$ 198.770 M

Monetary values presented in millions of dollars.
+ KWPCRF = Kansas Water Pollution Control Revolving Fund / CDBG = Community Development Block Grants / RD = Rural Development Grants and Loans
++ Total includes "Green Innovative" nonpoint source pollution control projects funded by ARRA/KWPCRF

Green Project Reserve / Nonpoint Source Pollution Projects

One of the Goals in the Kansas Nonpoint Source Management Plan is to institute a revolving loan fund for Nonpoint Source Projects (NPS). While a revolving loan fund for NPS projects has not been achieved, great strides were initiated as a result of the American Recovery & Reinvestment Act (ARRA) of 2009. ARRA funding and requirements helped to facilitate a partnership between KDHE Watershed Management Section and KDHE Municipal Programs Section. Through solicitation of nonpoint source / green infrastructure projects, KDHE WMS was able to implement 11 projects, totaling $5.7 million, which utilize innovative technologies to sustainably manage stormwater and abate nonpoint source pollution.

In FFY 10 Watershed Management Section utilized 20% of the KWPCRF FFY 2010 funds (approximately $2.6 million) for Green Project Reserve Projects financed by Clean Water State Revolving Funds. The Call for Proposals outlined the submission requirements, project eligibility, and applicant qualifications for funding of an NPS project through the KWPCRF NPS program. Selected projects were notified of the funding award. Pre-award meetings were held in May 2011 to outline the application process and requirements, and the project continued through July 2011 to complete the loan application process to secure executed loan agreements. Five projects were selected for funding with FFY 2010 funds. The Watershed Management Section is planning to utilize 20% of the KWPCRF FFY 2011 funds ($2.6 million) for KWPSRF Green Project Reserve Projects in the coming fiscal year.

Special State Concerns and Recommendations

The current major environmental concerns for the waters of Kansas can be divided into three categories: agricultural concerns, municipal/industrial concerns, and nuisance aquatic species.

I. AGRICULTURAL CONCERNS

Agriculture exerts a profound influence on surface water quality conditions in Kansas. Erosion of cropland soils produces elevated concentrations of silt in many streams and lakes, often to the detriment of native aquatic and semiaquatic life. The presence of nitrogen- and phosphorus-containing fertilizers in field runoff promotes nuisance growths of algae and detracts from the recreational and drinking water supply uses of surface water. Stormwater runoff from feedlots, livestock wintering areas, and heavily grazed pastures introduces pathogens and oxygen consuming organic wastes into nearby lakes and streams, sometimes compromising the sanitary condition of these waters. Pesticide residues in drinking water supply lakes can pose potential long-term risks to human health.

Efforts to alleviate the impacts of agriculture on the aquatic environment have focused primarily on the abatement of soil erosion and proper management of chemical fertilizers, biocides, and livestock wastes. Although the wider adoption of agricultural BMPs is underway and should lead to measurable reductions in stream contaminant levels, runoff water quality is not the only agricultural factor limiting the use attainment of surface waters. Throughout much of western Kansas, decades of irrigated crop production have exacted a heavy toll on stream life by lowering groundwater tables, reducing base stream flows, and transforming formerly perennial waterbodies into intermittent or ephemeral systems. In some areas of northeastern Kansas, stream channelization has radically simplified the original aquatic habitats and decimated a formerly diverse fish and shellfish fauna. Impoundments (large and small) throughout the state have encouraged the establishment of predominantly nonnative fish assemblages, fragmented the remaining stream habitats, and diminished the seasonal peak flows required by certain native fishes for spawning and egg development.

The complete restoration of these degraded aquatic ecosystems would require large-scale habitat rehabilitation efforts and fundamental changes in the laws, policies, and attitudes currently controlling the use and allocation of water in this region. Some more readily implemented options for partially offsetting the historical effects of agriculture would include: the enhancement of minimum stream flows through the State-mediated purchase and retirement of senior water rights, the expansion of hatchery restocking programs for native fish and shellfish; the selective removal of lowhead dams and other barriers to fish migration; the installation of fish ladders and elevators on larger dams, and other related management initiatives – all in addition to concurrent improvements in agricultural practices. Most of these concepts are not new; for example, the importance of maintaining migrational corridors for fish was emphasized repeatedly by Kansas officials during the late nineteenth century but never seriously considered in the course of water resource development (reviewed by Angelo *et al*., 2003).

II. MUNICIPAL AND INDUSTRIAL CONCERNS

Discharging Wastewater Treatment Facilities and other point sources influence surface water quality throughout much of Kansas. Releases of inorganic nitrogen and phosphorus from some facilities promote blooms of filamentous or scum-forming algae in downstream waters and detract from their capacity to support primary and secondary contact recreation. Bypasses of raw or partially treated sewage occur each year, owing to treatment plant capacity limitations, malfunctions, operator error, and natural catastrophes. Such bypasses can result in fishkills and other serious water quality problems.

Stormwater runoff from lawns, golf courses, roadways, and parking lots often contains a complex mixture of chemical pollutants (*e.g.*, biocides, fertilizers, oil, grease, antifreeze, deicing salts, solvents, detergents, asbestos). These substances can prevent the development and maintenance of representative aquatic communities in receiving surface waters. Similarly, concentrations of mercury, polychlorinated biphenyls (PCBs), and other bioaccumulative contaminants in fish taken from urban streams may pose unacceptable risks to human consumers. In addition, data related to the accumulation of animal and human pharmaceuticals, hormones, personal care products, and other ubiquitous chemicals such as polybrominated diphenyl ether (PBDE) fire retardants are much needed in Kansas. Although the concentrations of such chemicals in the water column are most often minute, the processes of bioaccumulation and subsequent biomagnification in the food chain may concentrate these chemicals in fish tissue to levels that subject human and wildlife consumers to a risk of deleterious effects. Consumers of fish exposed to these contaminants and/or their degradation products may be exposed to concentrations in fish tissue from a few to tens of thousands of times the concentrations occurring in the ambient environment. Although the U.S. EPA has acknowledged the importance of monitoring these contaminants of emerging concern (CECs) in fish tissue (http://water.epa.gov/scitech/swguidance/ppcp/fish-expand.cfm) as well as water, analytical and financial support for implementation has not been forthcoming.

Unplanned urban growth can negatively influence the physical habitats supporting aquatic life, in part because the attendant elimination and alteration of permeable land surfaces, wetlands and riparian areas diminishes the capacity of urban watersheds to remove pollutants and mitigate the effects of flooding. Stormwater runoff from impervious surfaces such as paved areas and rooftops can lead to powerful flooding events, capable of scouring stream bottoms and eliminating the habitat required by some native aquatic species. The channelization of urban streams results in highly simplified aquatic habitats incapable of supporting the full range of fish and wildlife indigenous to this region. In many instances, the negative effects of urban development on streams, lakes, and wetlands could be reduced through careful planning and adherence to established BMPs and surface water quality standards. The retention of natural corridors or “greenways” along rivers and creeks, and strict adherence to the antidegradation provisions of the surface water quality standards (K.S.A. 28-16-28c(a)), would do much to preserve the natural physical and chemical attributes of the state’s urban streams. Local, state, and federal authorities also could support litter cleanup initiatives more enthusiastically. Improvements in the visual and aesthetic character of urban waters would increase the perceived value of these resources and encourage their protection and sustainable use.

Some streams in the state also suffer from the illegal dumping of trash and other unwanted materials. The practice of discarding grass clippings, brush, and animal carcasses into streams (and the subsequent decay of these materials) reduces dissolved oxygen levels and jeopardizes populations of fish and other aquatic life. Discarded paint cans, pesticide containers, and batteries may leach toxic materials, thereby posing a threat to resident aquatic biota.

On a positive note, the deliberate and systematic renovation of many wastewater treatment facilities across the state has produced noticeable improvements in surface water quality over the past few decades, and this progress continues. As point sources contributing to water quality impairments continue to decline, attention will shift increasingly to nonpoint sources. It is anticipated that watershed pollution control efforts, predicated largely on the development and implementation of TMDLs, will play an increasingly important role in the abatement of nonpoint source pollution in Kansas.

III. NUISANCE AQUATIC SPECIES

A number of exotic plant and animal species have established populations within the state, and some pose a serious risk to native aquatic life and the beneficial uses traditionally associated with surface waters. For example, Asian clams (*Corbicula fluminea*) have established large populations in streams and lakes throughout the state, and the zebra mussel (*Dreissena polymorpha*) has gained a foothold in recent years in several major river basins. Both of these exotic bivalves can compete with or otherwise injure native shellfish species, and both can impair designated recreational and drinking water supply uses. At least four species of Asian carp have been reported from the state, and additional exotic fishes are expected to appear in Kansas in the near future. These animals can compete with native fish for food and shelter, and some dramatically reduce water clarity by disturbing bottom sediments during feeding.

A number of introduced plant species also have proven problematic. Thickets of salt cedar (*Tamarix* spp.) have become established along many streams in western and central Kansas, crowding out the native riparian vegetation and removing (via evapotranspiration) vast amounts of water from the adjoining streams and underlying alluvial aquifers. Purple loosestrife (*Lythrum salicaria*) has become the dominant herbaceous species in many wetlands, overwhelming many of the state's native plants and jeopardizing the animals depending on these plants for food and shelter. Eurasian watermilfoil (*Myriophyllum spicatum*), an exotic plant sold in the aquarium trade, has been documented in several streams in western Kansas and in scattered lakes throughout the state. This plant propagates via seeds and vegetative fragments and can spread rapidly between waterbodies by attaching to boat propellers, boat trailers, and fishing gear. Once introduced into a lake or stream, it tends to form dense mats of vegetation that can interfere with recreational activities, crowd out native aquatic vegetation, disrupt the feeding behavior of native fish, and choke water intakes used for municipal water supply, power generation, and irrigation. An even more invasive and potentially damaging exotic aquatic plant (*Hydrilla verticillata*) has been discovered in two discrete locations in northeast Kansas during the last few years. The expansion of this exotic aquatic species carries with it, based on experiences elsewhere, and even greater potential for environmental and water infrastructure damage.

IV. CONCLUSIONS

Taken together, these threats can seem daunting. However, incremental efforts to abate the impacts of those activities are being made by various state and federal programs. For example, NPDES permits tying urban stormwater to impaired waters and directing appropriate corrective practices are being drafted. Kansas is implementing a State Nutrient Reduction Strategy to lower the presence of phosphorus and nitrogen in surface waters. Watershed Restoration and Protection Strategy (WRAPS) groups are directing funding to critical subwatersheds to reduce pollutant loads.

There have also been recent changes to state water use law that will encourage conservation; these include elimination of the "use it or lose it" rule for groundwater rights and introduction of multiyear flex accounts that allow irrigators to budget water use over five years rather than one (Kansas House Bill 2451 and Kansas Senate Bill 272; see Kansas Water Authority 2012).

Interagency collaborative efforts are increasing as well. Aggressive citizen education campaigns have been implemented to promote precautions and limit migration of invasive species among water bodies. Kansas Department of Wildlife, Parks, and Toursim, in partnership with the US Fish and Wildlife Service and the City of Wichita, is currently installing a fish passage structure in the Arkansas River, which is Designated Critical Habitat for several state-listed fish species. In addition, KDHE and KDWPT are also exploring funding options for construction and operation of a native freshwater mollusk and fish hatchery.

Over time, these programs can improve the health and intrinsic value of our aquatic ecosystems, thereby increasing their economic and cultural value to the citizens of Kansas. In order to implement these programs with efficacy, it is critical that we invest in continued systematic, thorough, high quality monitoring of our water. This will allow us to direct limited resources to the highest priority waters while building a foundation of sound scientific evidence to evaluate and improve our restoration strategies and measure their success.

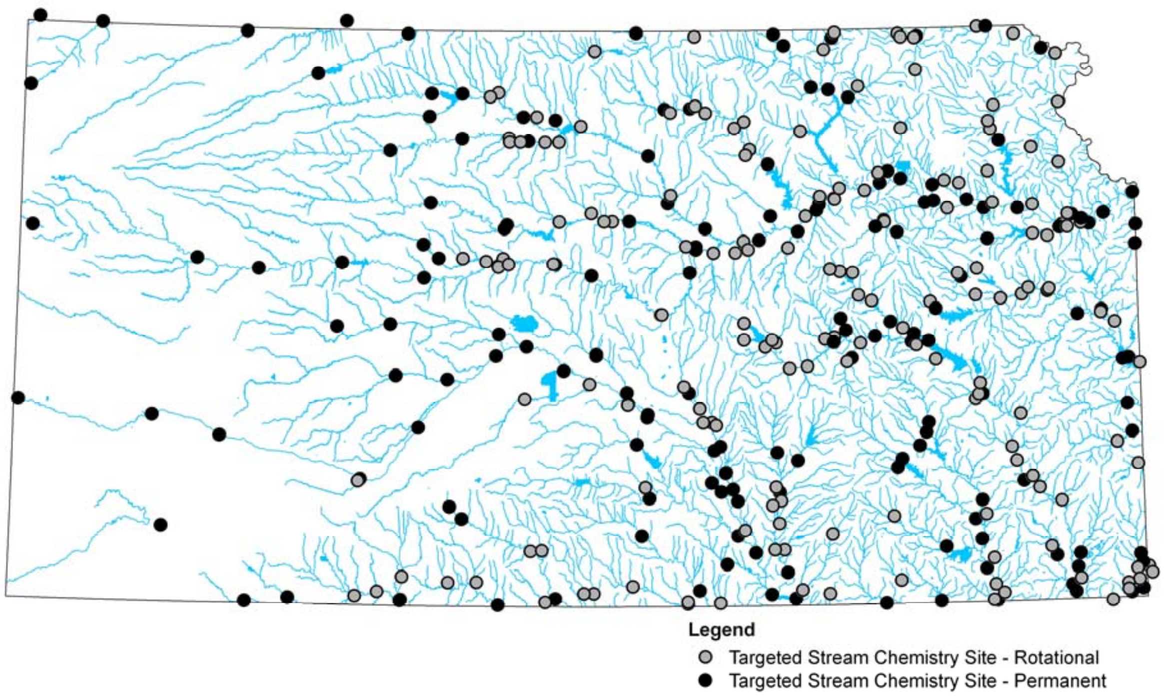
PART C. SURFACE WATER MONITORING AND ASSESSMENT

Monitoring Programs

I. TARGETED STREAM CHEMISTRY MONITORING PROGRAM

The stream chemistry monitoring program is the longest running environmental monitoring operation administered by the BEFS Technical Services Section. Water samples are obtained routinely from streams throughout Kansas and analyzed for a suite of physical, organic, inorganic, and bacteriological, and in some cases radiological parameters (**Appendix A**). The program database currently comprises over two million records representing nearly 400 active and inactive monitoring locations and approximately 100 different analytical parameters. Some records in the database date to the late 1960s, and several monitoring sites have a continuous period of record extending from that time to the present (KDHE, 2007a).

Figure 2. Targeted Stream Chemistry Monitoring Program Sites

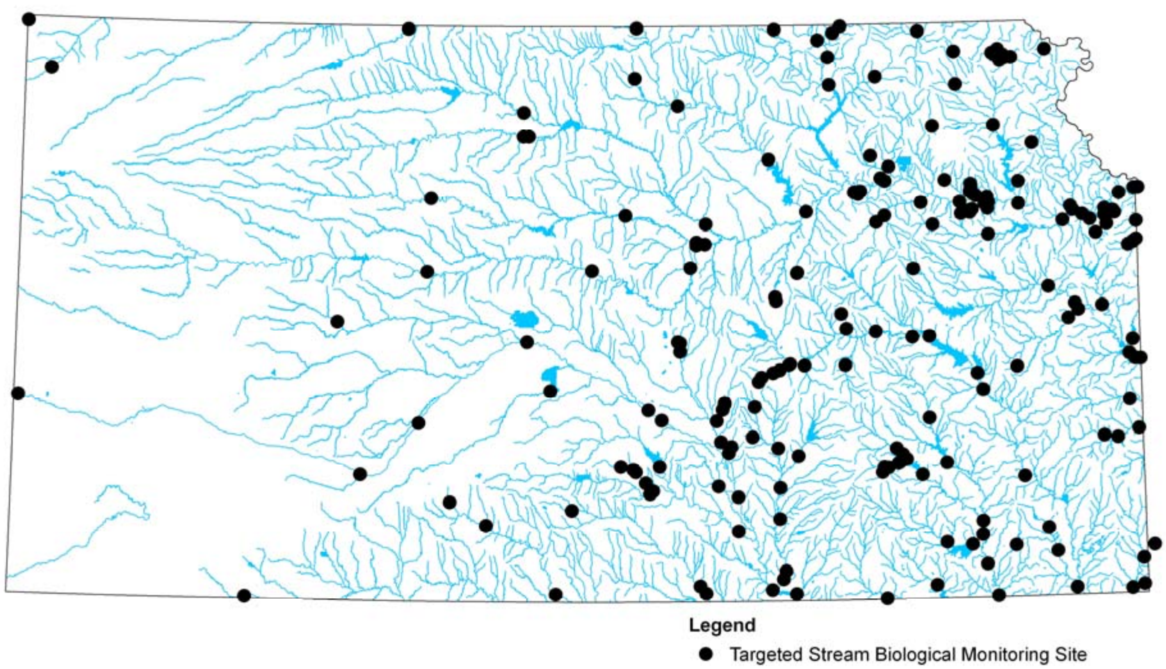


Currently, the stream chemistry sampling network comprises 328 active monitoring sites spanning all the major river basins and physiographic regions of Kansas (**Figure 2**). Monitoring personnel visit about 159 core sites on a quarterly basis every year, whereas the remaining 169 sites are monitored using a four-year rotational approach; *i.e.*, samples are collected quarterly from approximately 25 percent of rotational sites each year. Sampling sites have been chosen to represent water quality conditions in specifically targeted watersheds or stream reaches. For example, some sites reflect water quality conditions in streams as they enter or exit Kansas, others represent conditions above or below major WWTFs, urban areas, or reservoirs, and still others reflect water quality conditions in predominantly rural watersheds. A few “minimally altered” and several “least impacted” reference streams have been included in the network to gain a better understanding of baseline water quality conditions in the various ecoregions of Kansas (Chapman *et al.,* 2001). As currently configured, the network provides water quality information useful in the characterization of pollutant loadings from more than 97 percent of the state’s contributing drainage area. Many monitoring sites are located near the lower terminus of eight-digit hydrologic unit code (HUC) watersheds and play an important role in the development and refinement of TMDLs for 303(d)-listed streams.

II. TARGETED STREAM BIOLOGICAL MONITORING PROGRAM

This program examines the structural attributes of aquatic macroinvertebrate assemblages and utilizes this information to provide a more refined picture of the ecological status of streams in Kansas (KDHE, 2010d). Unlike water chemistry measurements alone, which reflect conditions occurring at the moment of sample collection, biological monitoring provides an integrated measure of environmental condition over time frames ranging from weeks to years, depending on the biological assemblage of interest. The majority of the program’s monitoring sites are also Stream Chemistry Monitoring Program sites. Fewer biological monitoring stations can be visited throughout the year than chemistry stations; however, combining biological and chemical sampling at selected key sites provide a more complete picture of ecological status than either method alone. Samples normally are obtained from 45-65 network sites each year as dictated by TMDL development needs, special projects, or other regulatory considerations.

Figure 3. Targeted Stream Biological Monitoring Program Sites



Over the course of 31 years, the program has developed a sampling network that includes over

200 current and historical monitoring sites distributed throughout the state; see **Figure 3.** Some stations have been sampled annually for the entire period of record, 32 stations have been sampled for 20 or more years, and another 74 stations have been sampled for 3 to 19 years. The program's database currently contains some 68,000 high resolution (predominantly genus/species level) records, and a separate freshwater mussel database contains approximately 15,000 high resolution records. Data from this program are used primarily in the development and refinement of TMDLs for 303(d)-listed streams.

III. PROBABILISTIC STREAM MONITORING PROGRAM

Probabilistic sampling is a method of environmental monitoring that yields statistically valid representative information on the physical, chemical, and/or biological condition of natural resources. It differs from conventional sampling in that probabilistic monitoring stations are a randomly selected subset of the resource as a whole. In Kansas, stream chemistry and stream biological monitoring programs traditionally have employed a targeted monitoring design that positions stations in a deliberate and strategic manner (*e.g.*, near the terminus of a specific watershed or above and below a discrete pollution source). Although these programs are of critical importance in determining site- and watershed-specific water quality conditions, funding and logistical constraints limit the number of targeted sites that can be sampled on an ongoing basis. In contrast, probabilistic monitoring focuses on the total resource rather than the individual monitoring locations. Results generated from this approach can be extrapolated with known confidence to the state's entire population of streams, including hundreds of smaller waterbodies (*e.g.*, headwater streams) largely outside the historical and current purview of the targeted monitoring programs.

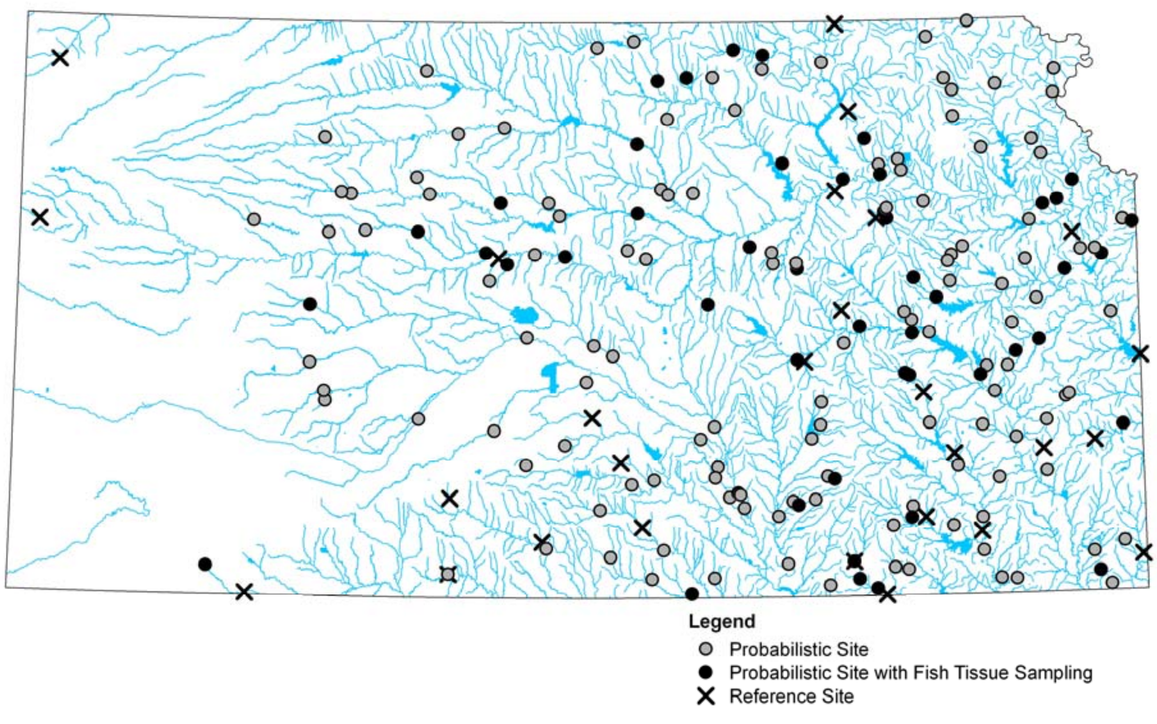
In 2004, KDHE participated in EPA's National Wadeable Streams Assessment and gained a familiarity with the application of probabilistic sampling designs and associated field methods (USEPA 2006 and http://water.epa.gov/type/rsl/monitoring/streamsurvey/index.cfm). In 2005, availability of supplemental monitoring funds under section 106(b) of the CWA provided an opportunity for BEFS to: (1) develop a quality assurance management plan and accompanying set of standard operating procedures for a similar statewide probabilistic program; (2) hire and train two environmental scientists to assist with the implementation of field and taxonomic duties; (3) develop a list of randomly selected (candidate) stream reaches; (4) obtain landowner permission to perform evaluations on these stream reaches; (5) initiate probabilistic monitoring operations; and (6) develop a methodology for applying probabilistic data to 305(b) water quality assessments. Probabilistic monitoring was formally implemented in June 2006 under the auspices of the newly created Kansas stream probabilistic monitoring program or SPMP.

From its inception, the SPMP was designed to complement, rather than supplant, the department's traditional monitoring programs. Probabilistic stream monitoring addresses 305(b) data needs, whereas targeted monitoring continues to serve as the primary basis for 303(d) list development, TMDL formulation, and NPDES permit review and certification. Although site selection procedures for the probabilistic and targeted monitoring programs differ substantially, field methodologies developed for the targeted programs have been integrated with little alteration into the probabilistic program. This decision has maintained methodological continuity across programs and facilitates inter-program data comparisons.

The SPMP sampling network is predicated on a random, but spatially balanced, site selection process (see Kaufmann *et al.*, 1991; Messer *et al.*, 1991; Larsen *et al.*, 1994; Urquhart *et al.*, 1998; Herlihy *et al.*, 1998, 2000). Site coordinates are based on the random selection of points from the universe of classified stream segments identified in the most recently approved version of the Kansas Surface Water Register (KSWR) (KDHE, 2010a). This register represents all potential sampling locations or "the sampling frame." It is subject to incremental change over time owing to the deletion or addition of classified stream segments (KAR, 2004; KDHE, 2005b). In effect, an infinite number of potential sampling sites can be selected from the KSWR, allowing a manageable subset of about 30–50 newly selected sites to be sampled each year. Additional details are given in the SPMP quality assurance management plan (KDHE, 2007b).

In addition to the 30-50 probabilistically selected monitoring sites sampled each year, the SPMP maintains a network of 25-35 reference-quality stations, which are chosen to reflect least disturbed waterbody types across the full range of stream sizes, ecoregions (Chapman *et al*, 2001) and major river basins; see **Figure 4.** These sites are sampled on a biennial basis using the same methodologies as those used on probabilistic sites. Data from these sites are used to derive thresholds for macroinvertebrate community-structure metrics, which are then used to assess the general population.

Figure 4. Probabilistic Stream Monitoring Sites, 2007-2010



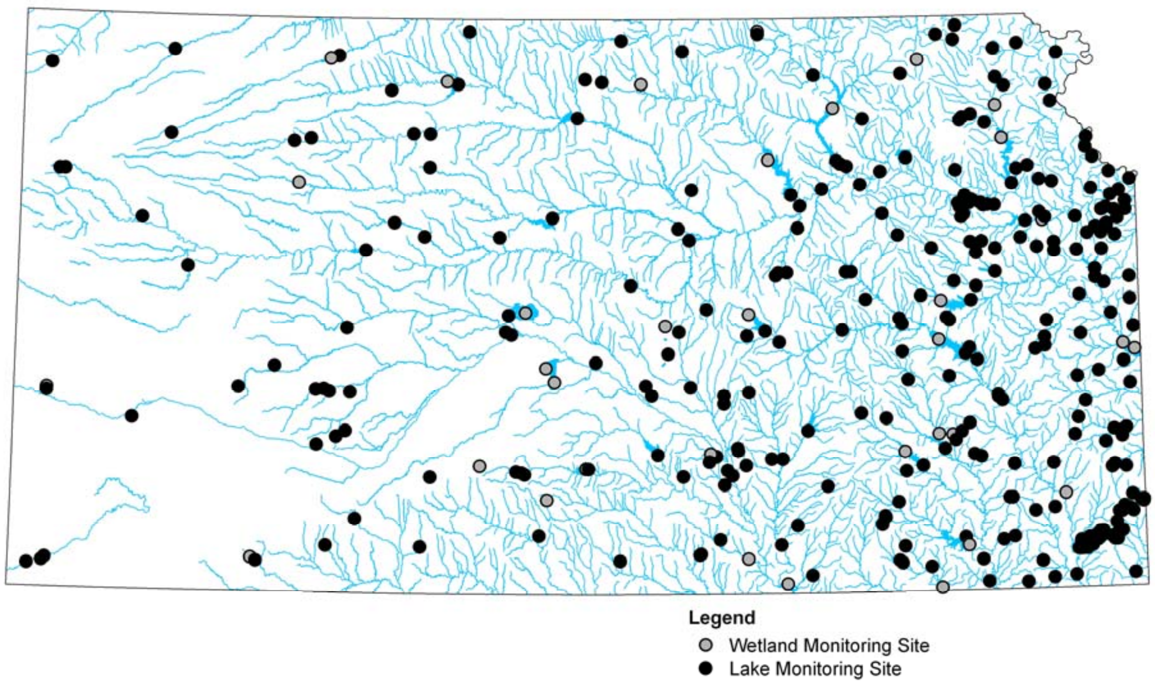
With assistance from staff of the targeted Stream Chemistry Monitoring Program (and using that program's protocols), samples are collected on a quarterly basis at each monitoring site; see **Appendix A** for parameters. During summer low flow of the same year, SPMP staff visit each site to sample the macroinvertebrate and phytoplankton communities. Physical habitat data also are collected to help discriminate between chemistry- and habitat-mediated constrains on the biotic community. The SPMP staff also obtain permissions to access a subset 12-15 of each year's sites that are on segments designated for food procurement. In cooperation with the Fish Tissue Monitoring Program staff, harvestable-sized edible fish are collected at these sites, and their fillets are screened for metals and organic contaminants. As mentioned previously, SPMP personnel employ many field protocols developed originally for the BEFS targeted monitoring programs and continue to work closely with staff from those programs, sharing in training, sample collection, and quality control and quality assurance methods. These established protocols are robust, and their utility has been demonstrated over the course of several decades. Moreover, data comparability and consistency among monitoring programs may prove important to future statewide water quality assessments. The SPMP database currently contains nearly 11,000 high resolution (predominantly genus/species level) macroinvertebrate records and over 1500 water chemistry records. Separate databases house additional information on physical habitat, freshwater mussels, phytoplankton, and fish tissue.

IV. TARGETED LAKE AND WETLAND MONITORING PROGRAM

This program surveys water quality conditions in publicly owned and/or publicly accessible lakes and wetland areas throughout Kansas; see **Figure 5**. Program personnel visit individual waterbodies on a three-to-five year rotational schedule, and field measurements and subsequent laboratory analyses provide data on a large suite of physical, chemical (inorganic and organic) and biological (phytoplankton and macrophytic communities) parameters (**Appendix A**). The program's primary database now contains around 300,000 analytical records representing more than 350 waterbodies. Watersheds associated with many of these lakes and wetlands are surveyed periodically with respect to prevailing land use/land cover and the location and size of discrete pollutant sources (WWTFs, CAFOs, etc.). Macrophyte community composition and aerial coverage are also evaluated in selected waterbodies smaller than 200 acres.

Baseline water quality information currently is obtained from a dynamic ambient sampling network of 117 selected lakes and wetlands distributed throughout the state (as of December 2011). These include all 24 federal lakes/reservoirs, most state-administered fishing lakes (those with open water in the majority of years), various other state, county or locally owned lakes, several privately owned but publicly accessible lakes (primarily for water supply), and five state or federally owned wetlands. Because only a small number of Kansas lakes are natural in origin, an effort has been made to identify artificial lakes in minimally disturbed/developed watersheds to serve the function of reference systems. This program routinely shares a large amount of data and expertise with other agencies and organizations involved with lake and wetland management, environmental restoration, water quality monitoring, and environmental education. Additional collaborative efforts have addressed the abatement of toxic algae blooms and taste/odor problems in public water supplies.

Figure 5. Targeted Lake and Wetland Monitoring Sites



V. FISH TISSUE CONTAMINANT MONITORING PROGRAM (TARGETED AND PROBABILISTIC)

This program obtains information on chemical contaminant levels in fish collected from streams and lakes in Kansas (KDHE, 2010b). The majority of river and stream fish tissue samples are collected by KDHE staff, although some lake samples are collected by the Kansas Department of Wildlife, Parks, and Tourism (KDWPT), and samples from some selected Kansas City area waterbodies are collected by USEPA Region 7 staff. All samples are analyzed by the USEPA Region 7 environmental laboratory.

Fish tissue samples are usually obtained from 30-40 waterbodies across the state each year utilizing both targeted and probabilistic sampling designs. Targeted sampling efforts focus on stream sites and lakes with known or suspected contamination, existing fish consumption advisories, or to monitor waterbodies where fish are heavily harvested by the fishing public. Probabilistic samples from streams and lakes serve a screening function to assess previously unsampled locations and provide unbiased data to determine statewide and regional contmaninant patterns. Probabilistic sample locations are identified by the Stream Probabilistic Monitoring Program and sampled cooperatively with staff from that program.

Although chlordane traditionally had been viewed as the contaminant of greatest concern (Arruda *et al.* 1987a-b; KDHE 1988a-b), chlordane concentrations in fish have declined dramatically in recent years, and attention has shifted gradually to mercury, PCBs, and a few other persistent contaminants. The agency has recently devoted a greater proportion of its monitoring resources to the collection and analyses of predatory fish from recreational lakes and reservoirs. This initiative acknowledges recent concerns with mercury levels in freshwater fish and the potential for mercury-related health problems, especially in more vulnerable segments of the human population (*e.g,.* children and women of child bearing age) (USEPA 2000a-b; http://epa.gov/waterscience/fish/advice/factsheet.html).

From 1980 to 2010, whole-fish composite samples (three to six individual fish) of bottom feeding fish were obtained biennially from up to eight selected long-term monitoring stations. Whole-fish composite samples offer an analytical advantage over fillet samples in that many organic contaminants (e.g. organochlorine pesticides and PCB's) accumulate to a higher degree in internal organs and fatty tissues. The resulting data are used to track the occurrence of these contaminants within the ecological food web, ascertain contaminant trends, and provide a measure of exposure that wildlife and human populations may be exposed to when consuming portions of fish other than fillets. Unfortunately, EPA support for whole-fish analyses has recently been withdrawn.

Composite fillet samples are obtained from both targeted and probabilistic stream and lake monitoring sites. Fillet plugs for mercury analyses were implemented in 2010. Fillet plugs allow for the analysis of mercury among individual fish within a sample. This new method provides several mercury data points within a sample, thus greatly increasing the utility of the data. KDHE utilizes composite fillet and fillet plug data to evaluate potential human health concerns related to mercury, heavy metals, organochlorine pesticides, and PCB's. Local site-specific advisories are issued, rescinded, or modified utilizing composite fillet and fillet plug data. Advisories are published at the beginning of each year jointly with KDWPT. The fish tissue database currently comprises over 20,000 records, representing 232 sites, and more than 200 contaminant parameters (of which 79 have been detected) (**Appendix A**).

Assessment Methodology

I. 305(B) ASSESSMENT METHODOLOGY FOR STREAMS

OVERVIEW

The target population for the 2012 probabilistic stream assessment comprised that portion of the Kansas Surface Water Register (KSWR) stream extent that contained water during the summer low-flow periods of 2007-2010. The sampling frame used to select sites for 2007-2009 was an interim register dated December 15, 2005, and the 2010 sites were drawn from a survey design based on the official February 12, 2009 register. Reporting was based on the segment geometries and uses published in the December 15, 2010 version of the register (KDHE, 2010a), which represents an extent of approximately 27,738 stream miles, based on a 1:100K resolution. This includes perennial rivers and streams as well as intermittent streams that provide important refugia for aquatic life.

Site selection was performed by the EPA design team in Corvallis, Oregon (Olsen, 2006) using the methods and assumptions of Stevens and Olsen (2004). All desk and field reconnaissance was performed by SPMP personnel, along with securing landowner permissions. The target population was determined to comprise 19,768 stream miles, or about 72% of the KSWR. Data collected during 2007-2010 were used to assess the prevailing level of support for CWA section 101(a) uses (**Table 8**).

Table 8. Types of data applied to assessment of designated use support for streams and rivers, 2007-2010

Designated Use	Macroinvertebrate Community Structure	Water Chemistry	*E. coli* Concentrations	Fish Tissue Chemistry
Aquatic Life	X	X		
Recreation			X	
Food Procurement				X
Overall	*X*	*X*	*X*	*X*

The capacity of a given stream reach to provide for recreation, food procurement, and aquatic life support was determined by considering the local water chemistry, fish tissue chemistry, suspended bacterial concentrations, and condition of the benthic macroinvertebrate community. Monitoring sites meeting the applicable water quality criteria or diagnostic thresholds for a given use were deemed "fully supportive" of that use. Any site failing to meet these criteria or thresholds was deemed "non-supportive" of the use. Note that the quantity of data and assessment methodologies used here are sufficient for a screening-level assessment for 305(b) purposes, but are not sufficient to support a 303(d) impairment listing or to issue state advisories or warnings.

Assigned causes and sources of nonsupport were based on several considerations, including the prevalence and proximity of upstream point sources and nonpoint sources, point source performance during the reporting period, dominant land uses within the watershed (and near the sampling location), and any instream manifestations reflecting degraded water quality (silt blanketing of sediments, large growths of filamentous or mat forming algae, presence or recent evidence of livestock in the stream channel, effluent odors, etc.).

The method for attributing causes and sources has been changed slightly from the previous Integrated Report. For this assessment period, causes have been assigned at the lowest identifiable causal level (*i.e.,* the most direct observable effect), and sources are the anthropogenic and environmental stressors to which the effects may be most logically attributed. Sources, too, were assigned at the lowest causal level possible.

AQUATIC LIFE USE

Stream macroinvertebrate data and water chemistry data from 172 randomly chosen sites were considered during the assessment of the aquatic life use (**Figure 2**). A site was deemed fully supportive for aquatic life only if both the macroinvertebrate community structure and the water chemistry indicated support.

In assessment of the macroinvertebrate community, primary use support was determined using the site scores for four biological metrics traditionally used by the Stream Biological Monitoring Program. These metrics are: macroinvertebrate biotic index (MBI), nutrient-organic Kansas biotic index (KBI-NO), Ephemeroptera-Plecoptera-Trichoptera index (EPT), and percent EPT specimens with respect to total macroinvertebrate abundance (%EPTCNT). A fifth metric, Total Taxa (TOTTAX), was used as a tiebreaker when other metrics were equivocal (Huggins and Moffett, 1988)

Support thresholds for these metrics were derived from an analysis of 26 reference streams, all sampled during the 2007-2010 assessment period (**Figure 4**). Reference and probabilistic sites were partitioned into three stream flow categories (<10 cfs; 10 to 99 cfs; ≥100 cfs) using 10-year median discharge estimates for the KSWR segment on which each site falls (Perry *et al.,* 2004). Within each flow category, support thresholds for the biological metrics were set at the 75th percentile (MBI and KBI-NO) or 25th percentile (EPT, %EPTCNT, and TOTTAX) reference site score (www.epa.gov/bioindicators/html/biological_endpoints.html). This procedure effectively adjusted the expected performance of each monitored stream reach on the basis of stream size, *e.g.*, a small stream would not be expected to support the same number of EPT taxa as a large river, but it would be expected to perform as well as a similarly sized stream in the absence of environmental stressors. Support thresholds derived from this process are presented in **Table 9.**

Table 9. Aquatic life use non-support thresholds for biological metrics across three stream

Flow Group	MBI	KBI	EPT	%EPTCNT	TOTTAX +
< 10 cfs	> 4.79	> 3.00	< 7	< 28	< 30
10 –99cfs	> 4.54	> 2.76	< 6	< 34	< 30
≥ 100 cfs	> 4.13	> 2.45	< 12	< 59	< 26

+ secondary metric

Scores for probabilistic sites were compared to the flow-adjusted thresholds and assigned a value of 0 (non-support) or 1 (full support). These values were averaged across the four primary metrics to obtain a final average value for each site. If an average support value exceeded 0.5, the site in question was deemed fully supportive of the aquatic life use. If an average value was less than 0.5, the site was considered non-supportive of the aquatic life use. If an average value was exactly 0.5, the "total taxa" metric was used as a tiebreaker to determine support.

Water quality was also used to determine aquatic life support. Kansas has separate numeric water quality criteria for chronic versus acute water quality conditions as they relate to aquatic life (KDHE, 2005a). Data were checked against both sets of criteria, but exceedences of chronic water quality criteria were excluded if they were determined to have occurred during unstable-flow periods. If pollutant or parameter concentrations were found to exceed a given acute or chronic aquatic life criterion in at least 25% of samples, the site in question was deemed non-supportive of the aquatic life use.

CONTACT RECREATION USE

All probabilistic sites were assessed for recreational use support based on measured suspended concentrations of *Escherichia coli*. This bacterium is part of the normal intestinal fauna of humans and many other warm blooded animals. It is utilized in many water quality studies as a general indicator of fecal contamination. For formal (*e.g.*, 303(d)) regulatory purposes, bacteriological criteria generally are applied as geometric mean concentrations, calculated using data from at least five different samples collected in separate 24-hour periods during a 30-day assessment window (K.A.R. 28-16-28d-e). The frequency and timing of the SPMP sample collections did not meet these rigid requirements. Therefore, the results reported below for the state as a whole (*i.e*., pursuant to section 305(b) of the CWA) were based on seasonal samples collected from each probabilistic site over the course of a single year.

Based on studies undertaken previously by the former BEFS Use Assessment Section, each stream segment listed in the KSWR was assigned to one of four recreational use categories (two primary and two secondary) depending on stream size, extent of public access, and other use attainability considerations (KDHE, 2005b). *Escherichia coli* data from each probabilistic site were compared to the applicable criterion concentration. Many of these sites were designated for secondary contact recreation only, in which case all available data were combined and the geometric mean was compared directly to the appropriate criterion concentration. Sites designated for primary contact recreation were evaluated with respect to recreational season (primary contact, April 1 – October 31; secondary contact, November 1 – March 31), and the geometric mean for each season was compared to the appropriate criterion concentration (**Table 10**). If the geometric mean exceeded the applicable criterion concentration during any season, the monitoring site in question was deemed non-supportive of the recreational use.

Table 10. *Escherichia coli* criteria used in recreational use assessments

Use	Colony Forming Units (CFUs)/100mL	
Primary Contact Recreation	Geometric Mean April 1 – Oct. 31	Geometric Mean Nov. 1 – March 31
Class B	262	2,358
Class C	427	3,843
Secondary Contact Recreation	Geometric Mean Jan. 1 – Dec. 31	
Class a	2,358	
Class b	3,843	

FOOD PROCUREMENT USE

Fish tissue contaminant data were obtained from 48 of the 172 probabilistic stream sites during 2007–2010 (**Figure 4**). All of the corresponding stream segments were on KSWR stream segments designated or proposed for food procurement use and were regarded as viable candidates for collection of harvestable size and species of fish. At each site, personnel endeavored to collect one composite (three- to five-fish) sample of a representative bottom-feeding fish species (*e.g.*, channel catfish, common carp) and another composite sample of an open-water predatory species (*e.g.*, largemouth bass). Food procurement use support was assessed on the basis of measured contaminant concentrations and contaminant-specific hazard threshold values for a consumption rate of greater than two meals per month (USEPA, 2000a-b). For contaminants with both carcinogenic and non-carcinogenic endpoints, the more conservative of the two endpoints was applied in the 305(b) assessment (USEPA, 2000a-b). Fish contaminants rated as carcinogens were assessed on the basis of EPA cancer potency factors and an allowable population cancer risk of 1:100,000. Non-carcinogens were evaluated using EPA health endpoints for chronic systemic effects. Further assumptions included consumption of fish tissue over the duration of an average human lifetime, average adult body weight, and eight-ounce meal portions. If the level of a contaminant was found to surpass the applicable threshold concentration, the site in question was deemed non-supportive of the food procurement use.

POPULATION EXTENT ESTIMATION

Data from the 172 sites assessed for aquatic life and contact recreation and from the 48 sites assessed for food procurement were used to derive estimates for the target population as a whole. If a site failed to support any single designated use, it was considered non-supportive overall. The design team at the EPA Western Ecology Division provided the population extent and variance estimates given in this report (personal communication, Tony Olsen). Calculations were performed using the “R” programming environment (www.r-project.org), the most current “sp” and “spsurvey” custom software modules (www.epa.gov/nheerl./arm/analysis pages/software.htm), and the methods and assumptions of Diaz-Ramos *et al*. (1996) and Stevens and Olsen (2003).

II. 305(B) AND 314 ASSESSMENT METHODOLOGY FOR LAKES AND WETLANDS

In effect, KDHE takes a census-based approach to monitoring the lakes and wetlands on the Kansas Surface Water Register. This targeted monitoring program assessed 317 publicly owned and/or publicly accessible lakes during the six year period of 2006-2011, plus a total of 36 publicly owned/accessible wetland areas (**Figure 3**). Physicochemical and biological data were obtained from each waterbody and compared to established water quality standards and guidelines to characterize the level of use support. A lake or wetland was deemed non-supportive of a designated use if more than 25% of the samples exceeded a given criterion associated with that use, partially supportive if more than 10% (but <25%) of the samples exceeded the criterion, and fully supportive if <10% of samples exceeded the criterion. This assessment focused primarily on epilimnetic water quality conditions, utilizing samples collected from zero to 3.0 meters in depth.

Table 11. Mean chlorophyll-a thresholds used as support criteria for six designated uses

Support level	Designated Use	
	-Primary Contact Recreation -Domestic Water Supply	-Irrigation -Livestock Watering -Secondary Contact Recreation -Aquatic Life
Fully supportive	<10 ug/L	<18 ug/L
Fully supportive but threatened	10-12 ug/L	18-20 ug/L
Partially supportive	>12-20 ug/L	20-30 ug/L, or 20-56 ug/L with no blue-green algal dominance of the phytoplankton community
Non-supportive	>20 ug/L	>30 ug/L, with blue-green algal dominance, or >56 ug/L, regardless of algal community composition

The 305(b) assessment also considered long-term trends in trophic state condition for these 353 lakes and wetlands. Mean concentrations of chlorophyll-a were calculated for each waterbody based on the period of record for that waterbody. Concentrations were compared to an existing set of thresholds used to interpret narrative standards for lake trophic state, nutrient enrichment and turbidity (KDHE, 2005a). Mean chlorophyll-a thresholds for the support of six assessed designated uses are shown in **Table 11**.

III. 303(D) ASSESSMENT METHODOLOGY

Overview

The 2012 list of impaired (Category 5) waters builds upon listings developed in 2010. A complete description of the procedures and assumptions applied during the preparation of this list is provided by the report, "Methodology for the Evaluation and Development of the 2012 Section 303(d) List of Impaired Water Bodies for Kansas," which is published at http://www.kdheks.gov/tmdl/methodology.htm.

Development of the 2012 list relied primarily on data from targeted water quality monitoring programs administered by BEFS and described elsewhere in this report. The statewide water quality assessment prepared by BEFS pursuant to section 305(b) of the CWA also provided initial waters for listing, particularly lakes, wetlands and stream biology. BOW performed more extensive follow-up analyses, particularly on stream chemistry, as the final basis for identifying and listing impaired waters in Kansas.

Stream chemistry data were obtained from the statewide network of targeted permanent monitoring stations (assessment period 2002-2011) and rotational stations (assessment period 1990-2011, except toxics which were assessed 2000-2011). Analysis for conventional pollutants used binomial techniques, adjusted to minimize Type II errors. Analysis for toxics (acute or chronic) simply looked at frequency of digressions greater than once every three years. Streams suspected of being impaired by excessive total phosphorus or total suspended solids were identified by median concentrations exceeding screening values. Numeric criteria for either of these pollutants will be developed as part of the implementation sequence for TMDLs addressing either impairment.

Watersheds monitored by the individual stream chemistry stations comprise multiple stream segments as an assessment unit for the purposes of the 303(d) program. Waters flowing directly into some large reservoirs were not surveyed as part of the stream chemistry monitoring network, instead being assigned to the assessment unit associated with that reservoir.

The public notice for the 2012 draft 303(d) list provided a mechanism for soliciting all readily available and existing water quality data from other agencies. In most cases, any submitted data corroborated the conclusions reached from the corresponding KDHE data. The final 303(d) list identified 524 Category 5 water quality impairments (http://www.kdheks.gov/tmdl/2012/303d_List_Long.pdf).

Priorities and Schedules

Since 1999, TMDL development efforts in each of the state's twelve major river basins have attempted to adhere to a five-year rotational schedule. The 2012 303(d) list identifies water bodies in selected basins slated for TMDL development between the summer of 2012 and the summer of 2014. During the next two-year cycle, TMDL development and revisions will focus on waters in the Marais des Cygnes, Missouri, Neosho, Walnut and Verdigris basins. The priorities for TMDL development will concentrate on addressing impairments from excessive phosphorus, bacteria or suspended solids. Additionally, EPA guidance suggests that TMDL development commence within 8-13 years from the original listing year. A large number of listings on the 2012 list in those basins have been carried forward from previous lists dating back to 2002. Hence, those listings will be 10-12 years during the upcoming cycle, and it will be a priority of KDHE to develop their associated TMDLs during the next two years. Because of these priorities and their associated work load, no TMDLs are anticipated to be developed in the Verdigris Basin during this upcoming cycle. The work load anticipates some revision of existing TMDLs for important water bodies to facilitate implementation of corrective actions.

Tracking Previously Listed Waters

The 2012 303(d) list also identifies waters from previous lists that were once impaired by a pollutant (Category 5) but that are now placed in other listing categories established by EPA. Waters with approved, established TMDLs are placed in Category 4a. Such waters in Kansas were cited as impaired on the 1998, 2002, 2004, 2008 or 2010 303(d) lists; these are published at: http://www.kdheks.gov/tmdl

A small number of water bodies have been designated as Category 4b, meaning their particular impairments have been addressed by some means other than development of a TMDL. Previous Category 4b waters addressed through appropriate limits, schedules of compliance and other conditions placed on NPDES permits are now achieving the respective water quality criteria and have been placed in Category 2, the category indicating for Kansas waters, those that were once impaired, but whose water quality has subsequently been restored. Effluent quality data from individual facility discharge monitoring records, corresponding water quality data at downstream monitoring stations and special monitoring efforts upstream and downstream of selected facility outfalls support the transfer of those waters to Category 2.

Atrazine impairments in a limited number of water bodies in the Little Arkansas River watershed have been addressed through implementation of the Watershed Restoration and Protection Strategy (WRAPS) watershed plan. Continuation of Category 4b status is contingent upon ongoing efforts and results to abate atrazine loads in the selected subwatersheds of the Little Arkansas River. Because of the burden of proof placed on designated waters into Category 4b, it is unlikely that additional entries will be made into that category. Other WRAPS groups may address impairments through implementation of their watershed plans, but the impaired waters will remain in Category 5 until those impairments are remedied or a TMDL has been established.

Only one stream system in Kansas has been designated as Category 4c, used for waters impaired by factors other than pollutants (habitat, flow alterations). Biological impairment as defined by macroinvertebrate monitoring appears to be linked to pervasive low flows during drought, perhaps exacerbated by water diversions. The impairment is better suited for management through water allocation and water right administration. As this watershed is in the Marais des Cygnes, the Category 4c status will be re-evaluated during the coming cycle.

Category 3 is used by Kansas when there is uncertainty as to the impaired status of a given water body. Insufficient data exist to determine if the water is newly impaired, now restored or continued impaired. Relatively new stations with small sample sizes would be placed in this category as would previously impaired waters that now are just barely compliant under the applicable analysis using recent data. Additional monitoring and subsequent analysis in coming listing cycles will move waters from Category 3 into Categories 2, 4a or 5.

Waters are placed in Category 2 as a result of analysis of current data, changes in water quality criteria or the removal of certain designated uses through the Use Attainability Assessment process. In some cases, corrective actions on point and non-point sources of the pollutant have improved conditions to restore the applicable water quality standard. Ammonia and chlordane are two pollutants that reflect cases in which point source improvements (lowered ammonia) or an outright ban (chlordane in 1988) resulted in improved quality seen ambient stream concentrations, fish tissue concentrations, and biological monitoring results.

Any surface water that has not been cited as impaired in the past or present is designated as Category 1, signifying that all its designated uses are being fully supported. All category assignments are recorded by KDHE in electronic databases, with the most recent revision tied to the 2012 listing process and submitted to KDHE as part of the 2012 integrated report and 303(d) listings package.

Assessment Results

I. 305(B) ASSESSMENT RESULTS FOR STREAMS AND RIVERS (PROBABILISTIC DATA)

The KSWR identifies all currently classified stream segments in Kansas. Collectively, these represent about 27,738 stream miles and include both perennial and intermittent waters. During prolonged droughts, some of this mileage is expected to be nonviable for sampling purposes. In addition, a given intermittent segment may not contain sampleable water at a randomly-chosen point along its length, especially during summer low-flow. Thus, the target sampling population is restricted to those reaches on classified stream segments that contain substantive aquatic habitats during the assessment period of interest. These habitats may include continuously flowing reaches, continuously wetted but non-flowing reaches, or isolated pools deemed capable of providing refugia for aquatic life.

Table 12. Probabilistic stream assessment fact sheet

Project Name	Kansas stream probabilistic monitoring program
Type of Waterbody	Stream or river
Units of Measurement	Miles
EPA Survey Design Project IDs	KSR06950 and KS2010
Sample frame for assessment	Dec 15, 2010 Kansas Surface Water Register
Size of sample frame	27,738 miles
Designated Uses	Aquatic life, contact recreation, and food procurement +
Size of Target Population	19,768 miles for Aquatic Life and Contact Recreation 13,866 miles for Food Procurement +
Percent supporting all uses assessed	25.4 ± 3.6%
Percent not supporting one or more uses	74.6 ± 3.6%
Percent nonresponse	0%
Indicators	Macroinvertebrate community assessments, water chemistry analyses, fish tissue contaminant analyses, *E. coli* measurements
Assessment Date	March 22, 2012
Precision	95%

+ Food Procurement Use does not apply to the entire Kansas Surface Water Register. For this assessment period, it applied to only 70% of the target population.

Based on a combined desk and field reconnaissance, the target sampling population during the summers of 2007-2010 was estimated at 19,768 stream miles or approximately 71% of the total classified stream mileage. This extent was assessed for recreational and aquatic life support uses with chemical and biological data from 172 monitoring sites. As discussed previously, the food procurement use was assessed using fish tissue contaminant data from 48 sites. **Table 12** highlights some of the major features of the probabilistic sampling effort.

STREAM USE SUPPORT IN RELATION TO INDIVIDUAL DESIGNATED USES

The uses of surface water recognized in section 101(a) of the CWA correspond to the following three designated uses in Kansas: aquatic life support, recreation, and (human) food procurement (K.A.R. 28-16-28b *et seq.*). The first two uses apply in some form to virtually all streams listed in the KSWR. The food procurement use, on the other hand, is assigned only to a portion (64%) of the state's classified stream mileage – those rivers and streams that have been determined likely to contain edible fish of harvestable size. The Kansas surface water quality standards recognize additional uses of surface water, but these are not considered in this probabilistic assessment (**Table 13**).

Table 13. Allocation of designated uses among classified streams

Designated Use	Proportion of Mileage Designated for Use +
Aquatic life support (any category)	100%
Contact recreation (any category)	~100% ++
Food procurement	64%
Livestock watering	95%
Irrigation	92%
Groundwater recharge	91%
Industrial water supply	74%
Domestic water supply	71%

+ Mileage given relative to the entire December 15, 2010 KSWR extent of 27,738 miles
++ The few streams with no formal use designation for aquatic life (0.3% of total mileage) were assessed here using the least restrictive (class b) criteria.

Table 14 presents use support findings for individual section 101(a) uses (aquatic life support, contact recreation, and food procurement), and **Table 15** illustrates overall support as well as the overlap among support and non-support for all three uses. The indicated 95% confidence intervals were derived using a local variance estimator approach (Stevens and Olsen, 2003). Although only about 25% of mileage supported all three uses, less than 3% of mileage failed all three uses. Most stream mileage in Kansas supported one or two of the three assessed designated uses.

Table 14. Support of individual designated uses in streams (in miles)

Designated §101(a) Use	Total Targeted Extent	Total Assessed Extent	Extent Supporting Indicated Use*	Extent Not supporting Indicated Use*	Extent with Insufficient Data
Aquatic Life	19,768	19,768	8,160 ± 593	11,608 ± 593	0
Contact Recreation	19,768	19,768	15,976 ± 494	3,793 ± 494	0
Food Procurement	13,866	13,866	8,130 ± 849	5,737 ± 1,073	0

95% confidence intervals derived using local variance estimator approach (Stevens and Olsen, 2003)
Food procurement confidence intervals are not symmetrical because food procurement monitoring was a subsample rather than an exhaustive sample.

Table 15. Detailed account of use support for streams (in miles)

		Food Procurement Support	Food Procurement Non-support
Aquatic Life Support	Contact Recreation Support	5,026 ± 731	1,828 ± 549
	Contact Recreation Non-support	0	1,230 ± 701
Aquatic Life Non-support	Contact Recreation Support	7,056 ± 863	2,157 ± 726
	Contact Recreation Non-support	1,949 ± 323	522 ± 323

CAUSES AND SOURCES OF STREAM IMPAIRMENT

Table 16. Major causes of water quality impairments in streams

Cause category	Cause (with ATTAINS cause code)	Impaired Mileage
Water chemistry	Atrazine (148)	1,034 ± 291
	Cadmium (239)	230 ± 139
	Chloride (272)	115 ± 102
	Copper (345)	115 ± 101
	Lead (663)	575 ± 203
	Selenium (984)	1,494 ± 331
	Ammonia (122)	230 ± 145
	Dissolved oxygen (449)	1,149 ± 292
Waterborne pathogens	*Escherichia coli* contamination (471)	3,793 ± 494
Biological assessment	Aquatic macroinvertebrate bioassessment (135)	11,148 ± 592
	Nutrient eutrophication biological indicators (791)	8,390 ± 609
Fish tissue chemistry	Mercury in fish tissue (696)	5,737 ± 943

Likely causes and sources of non-support were determined for each probabilistic monitoring site exhibiting water quality impairments. This phase of the water quality assessment used habitat data collected on-site, aerial photographs along with geographical map coverages identifying watershed boundaries and water resources, point and nonpoint sources of pollution, general land use, land cover, and soil characteristics, and aerial photographs. Findings were extrapolated to the overall population of streams targeted during the 2007-2010 assessment period. Because multiple causes and sources of impairment were associated with some individual monitoring sites, there is overlap among their extent, and thus stream mileage affected by all causes and sources was not amenable to meaningful summation.

Major causes of non-support for streams, in order of prevalence, were aquatic macroinvertebrate community metrics, nutrient eutrophication biological indicators, mercury in fish tissue, and *E. coli*. Other directly-measured water quality parameters (high metals, ammonia, and atrazine, and low dissolved oxygen) combined to form a fifth functional stressor category (**Table 16**).

Sources responsible for pollutant loadings and/or use impairments can be separated into four general categories. The most prevalent of these was agriculture (both crop and livestock production), followed by general anthropogenic influences (e.g., erosion and sedimentation, atmospheric deposition of contaminants) and other factors (including natural sources); urban influences (both point and nonpoint) comprised a relatively minor source of use nonsupport (**Table 17**).

Table 17. Major sources of water quality impairments in streams

Source Type	Source	Impaired mileage
Urban	Waterwater treatment facility (520)	805 ± 261
	Industrial point source (239)	115 ± 101
	Unspecified urban stormwater (41)	345 ± 173
Agricultural	Crop related sources (45)	1,034 ± 291
	Confined animal feeding operations (477) [in watershed]	1,149 ± 297
	General animal agriculture (85) [in watershed]	9,769 ± 625
	Livestock (510) [observed onsite]	2,184 ± 387
General anthropogenic	Atmospheric deposition (109)	5,737 ± 943
	Mining (70)	230 ± 107
	Water withdrawal (358)	805 ± 250
	Hydrologic modification (563)	115 ± 94
	Habitat modification (335)	919 ± 261
	Erosion and sedimentation (56)	6,666 ± 622
	Eutrophication (189)	1,609 ± 340
Other	Drought related impacts (12)	230 ± 141
	Natural source (531)	1,494 ± 324
	Wildlife (230)	230 ± 141
	Habitat (258) [inadequate habitat]	1,609 ± 347
	Source unknown (292)	2,643 ± 449

The 2000-2006 drought in Kansas, one of the most severe since the 1950s, ended in June of 2007, at which time the southeastern portion of the state received nearly 20 inches of rain in a five-day period. These rainfall events resulted in major floods that scoured many waterbodies. They also resulted in sustained high stream flows for much of the summer. The combined effects of these dramatic weather-related events clearly contributed to many of the stream impairments documented during 2007. Although this assessment indicates that many stream systems may be in suboptimal or impacted condition, it also demonstrates that they have capacity for improvement. Mitigation of major identifiable stressors could result in restored stream health.

II. 305(B) AND 314 ASSESSMENT RESULTS FOR LAKES AND WETLANDS

Lakes Assessment

BACKGROUND

A total of 317 publicly owned or publicly accessible lakes are included in this reporting cycle. This represents all lakes known to KDHE through monitoring activities, as well as from sources published by other agencies (most notably Kansas Department of Wildlife, Parks and Tourism (KDWPT) and the Army Corps of Engineers (ACOE)). These lakes comprise a total of 191,304 acres of surface area at normal conservation pool levels. Lakes with their shorelines under common private ownership are considered private lakes in Kansas, but may still be public waterbodies under state water quality standards if they supply public drinking water or are open to the general public, by invitation or fee, for recreational use.

For the purposes of this report, all publicly owned/accessible lakes, reservoirs, and ponds are referred to as “significant” public waterbodies. This is based on the assumption that any lentic waterbody that is owned by, or accessible to, the general public will provide benefits to the general population. These benefits may include recreation and water supply, but will also certainly include habitat for the support of indigenous aquatic and semi-aquatic organisms, including fish and migratory waterfowl.

Unless specifically identified as a wetland all lentic waterbodies will be referred to as “lakes” within this report, regardless of size or origin. This is done in order to avoid the arbitrary thresholds separating ponds from other waterbodies, and to recognize the fact that we assign and expect the same benefits from constructed lakes as we do from naturally formed ones.

Table 18 presents a comparison of lake acreage investigated, during the 2006-2011 period of record for this 305(b) reporting cycle, versus the means by which Aquatic Life Use Support (ALUS) assessments were determined. Assessments utilize a period of record of 6 years for physical/chemical data and the entire period of record for trophic state data for trends. At all monitored and evaluated lakes, KDHE surveys utilize chemical, biological, and physical components, which also factor into metrics related to habitat.

Table 18. Categories of data used in ALUS assessments for lakes (in acres)

Degree of Aquatic Life Use support (acute criteria only)	Assessment based on biological habitat data only	Assessment based on physical/chemical data only	Assesment based on both habitat and physical/chemical data	Total acres assessed
Insufficient Data	0	0	0	102
Fully Supported	0	0	114,436	114,436
Fully Supported but Threatened	0	0	11,064	11,064
Partially Supported	0	0	61,488	61,488
Not Supported	0	0	4,214	4,214

IMPAIRED AND THREATENED LAKES

Table 19. Summary of Fully Supporting, Threatened, and Impaired Lakes

DEGREE OF USE SUPPORT	Assessment Category		Total assessed acres
	Evaluated	Monitored	
Insufficient Data	102	0	102
Fully Supporting of All Uses	7,597	13,431	21,028
Threatened for One or More Uses (But Not Impaired for Any Uses)	243	2,412	2,655
Impaired for One or More Uses	6,718	160,801	167,519
Total Size Assessed	14,660	176,644	191,304

Table 19 summarizes overall use support ratings for lakes assessed during this 305(b) cycle, and **Table 20** divides assessments into specific beneficial uses. The majority of lake acreage is monitored, as can be seen in **Table 19**. Fully 92.3% of reported lake acres are considered to be monitored and, thus, are monitored for "toxics" such as heavy metals and pesticides as well as the other inorganic and biological parameters common to KDHE lake surveys. Of the 176,644 monitored lake acres, 13,906 acres (7.9%) show some level of impairment from heavy metals and/or pesticides.

Table 20. Individual use summary for lakes (in acres)

Goals	Use	Size Assessed	Fully Supporting	Fully supporting but threatened	Partially Supporting	Non Supporting	Insufficient Data
Protect and Enhance Ecosystems	Aquatic Life (acute criteria)	191,304	114,436	11,064	61,488	4,214	102
Protect and Enhance Public Health +	Fish Consump-tion++	191,304	190,283	0	358	641	22
	Primary Contact	191,177	30,929	9,195	146,953	4,020	80
	Secondary Contact	191,304	118,623	11,068	57,652	3,859	102
	Domestic Water Supply	189,524	20,889	5,619	112,945	49,991	80
Social and Economic Enhancement +	Irrigation	190,669	150,323	11,065	25,793	3,408	80
	Livestock Water Supply	190,684	149,605	11,068	25,763	4,168	80

+ = Shellfishing and Cultural Use categories not applicable.
++ = Based on food procurement criteria for water as well as fish tissue analysis. During the 2006-2011 time period, 50 lakes, comprising 132,333 acres, were also assessed for fish tissue burdens of heavy metals, PCBs, and pesticides.

During the course of the last decade, all lakes listed in the Kansas Surface Water Register have undergone UAA surveys for the entire suite of possible designated uses. These use attainability surveys have included water chemistry, including heavy metals and pesticides. Many of these recent UAA surveys have been at lakes considered as evaluated sites. For this reporting cycle, 14,660 acres of evaluated lakes have been examined for heavy metals and pesticides (*i.e.,* toxics), of which 6,349 acres have documented some level of impairment due to these parameters (43.3% of total).

Table 21 presents information related to direct and indirect causes of water quality impairments for this reporting cycle, while **Table 22** presents similar information regarding sources. Code numbers associated with causes and sources are the most applicable ATTAINS codes listed. In some cases, an exact and most appropriate single code number could not be settled upon. In those cases, several code numbers appear with the cause or source category. The tabular data should be viewed as applicable to a combination of two, or more, of the codes indicated.

Table 21. Total lake area impacted by various cause categories (in acres)

CAUSE CATEGORY AND CODES	ACRES BY CONTRIBUTION TO IMPAIRMENT	
	MAJOR	MODERATE/MINOR
Cause Unknown (247)	0	0
Pesticides - atrazine (148)	0	925
Heavy Metals – arsenic (145)	0	10,063
Heavy Metals – copper (345)	0	157
Heavy Metals – lead (663)	0	3,703
Heavy Metals – selenium (984)	0	8,540
Heavy Metals 693 (mercury)	0	221
Fluoride (555)	0	139
Boron (230)	0	0
Nutrients and Eutrophication (483 and 746)	32,844	137,519
High pH (620)	17	10,299
Low pH (678)	0	13
Siltation and Turbidity(995)	43,027	16,803
Low Dissolved Oxygen (449)	0	233
Chloride (272)	0	15,990
Sulfate (1016)	638	35,702
Flow Alterations (546)	613	3,502
Pathogen Indicators (471)	0	0
Aquatic Plants (481 and 140)	2	397
Zebra Mussels (650) +	73,740	20,590
Perchlorate (880)	128	0

+ Major impact from zebra mussels is determined by the documented presence of adults within the waterbody while moderate/minor impact is determined by documented presence of veliger larvae only, or by professional concerns of near-future infestation from upstream lakes and streams with documented infestations.

For the most part, the results for this reporting cycle are very similar to the results reported in past 305(b) cycles. Nutrients and eutrophication related impacts dominate the list of water quality problems, along with secondary effects of eutrophication, with agriculture, urban runoff, natural sources, and point source nutrient loads being the most dominant sources. Natural sources are primarily referring to climate and weather driven impacts (such as water depletion, wind resuspension of sediments, and shallow thermal stratification), naturally high salinity in some locales, or fluoride impacts. Natural sources account for virtually none of the nutrient/eutrophication or heavy metal related impacts in Kansas lakes.

Table 22. Total lake area impaired by various source categories (in acres)

Source category	Contribution to impairment	
	Major	Moderate/minor
Municipal Point Sources (3)	25,600	122,141
Agriculture (18)	34,848	122,298
Urban (64)	964	12,494
Resource Extraction (252)	0	1,037
Hydromodification (1)	3,619	7,127
Atmospheric Deposition (109)	0	232
Natural Sources + (12 and 142)	448	35,934
In-Lake Management (362)	104	153
Resuspension (205)	10,375	125
Introductions of Non-Native Organisms (129)	73,742	20,705
Unknown (496)	0	0

+ Refers mainly to climate and drought impacts plus background levels of salinity and fluoride.

Related to the predominant impact that nutrient pollution and the resulting eutrophication process has on lake use support, a recent activity within KDHE has been the description of what are generally referred to as "reference" trophic state conditions for lakes in Kansas. In essence, reference water quality conditions for lakes occur in watersheds with none-to-limited human activity and anthropogenic pollution loads. These "least impacted or better" waterbodies then describe the condition that would be generally attainable if polluting activities were reduced, well buffered, or otherwise mitigated in the general population of lakes and wetlands. Thus, reference condition provides a valuable and attainable water quality goal for a given class of waterbodies.

Based on the water quality and trophic state data collected since the 1970s for lakes in Kansas, the following general conclusions regarding reference trophic state conditions have been reached. Lakes in Kansas with minimal pollution loads can be expected to achieve mesotrophic-to-slightly eutrophic conditions (chlorophyll-a of under 10-to-12 ug/L), with low total nutrient concentrations (total phosphorus below 30-to-35 ug/L) and relatively high water clarity (Secchi depth deeper than 1.25-to-1.50 meters) (Dodds, *et al*., 2006; Carney, 2009). For this 305(b) cycle, about 30.3% of assessed lakes achieve "least impacted or better" status for nutrient levels and trophic state condition (25.2% of assessed surface area).

Table 23 lists the numbers and acreage of lakes impacted by nonpoint and/or point sources of pollution, plus those with no identified impairments. Although nonpoint source impairments impact more of the smaller lakes, most of the largest lakes in Kansas have both point and nonpoint sources present within their watersheds.

Table 23. Lakes with identifiable point and nonpoint source pollution contributions

Pollution Type	Number of Lakes	Acres of Lakes
Point Sources +	25	147,741
Nonpoint Sources +	258	174,011
No Identifiable Pollution Sources	56	7,693

Numbers include any level of point source contribution, and any magnitude and combination of nonpoint source pollution impacts. Due to the fact that lakes may have both source types within their watersheds, numbers will not sum to match the total number or acres assessed.

This reporting cycle does have one very significant difference, compared to previous 305(b) reports. Invasive zebra mussels (*Dreissena polymorpha*) have continued to expand into additional lakes in Kansas over the last two years. Sixteen lakes now have documented populations (adults or veligers documented), totaling 94,330 acres or 49% of reported lake acreage. This is double the lakes reported in the 2010 305(b) report, and approximately four times that reported in the 2008 305(b) report which was the first 305(b) to document zebra mussels in the state.

TROPHIC STATUS

Trophic state classification for Kansas lakes and wetlands is based primarily on the period of record observed chlorophyll-a (corrected for phaeophytin-a). The rationale is based on the idea that planktonic algal biomass, as estimated by chlorophyll-a, comprises the vast majority of the base of the typical lacustrine food web in Kansas. Although macrophyte communities do contribute to the overall biological production in our lacustrine food webs, it is very rare that they provide a large portion of that food web base in and of themselves. A more typical situation would be a large macrophyte community providing structure so an increased epiphytic and benthic base for a food web could arise. Because of this, and the fact that absence of macrophyte beds is a far more common concern for the water quality and health of Kansas lakes, adjustment of trophic state classification due to macrophyte beds is rare.

The observed level of chlorophyll-a provides a good estimate of overall lake productivity and production. In addition, higher levels of planktonic algal biomass correlate well with lower levels of aesthetic appeal and recreational opportunity, increased costs for producing drinking water, and increased problems for using lake water for livestock and irrigation (Willms, *et al*., 2002; Lardner *et al*., 2005; Dodds *et al.,* 2009). Because of these factors, the trophic state estimate also becomes valuable for assessing levels of overall support for lakes and wetlands in Kansas.

While higher levels of sedimentation are often concurrent with the eutrophication process in the Midwest, KDHE monitoring does not allow more than a rough indication of sedimentation impacts per se. For the majority of settings, sedimentation is inferred from shoreline and inflow area observations, as well as watershed land use configuration, and the general turbidity of a system. Where high turbidity seems a chronic problem, trophic state may alternately be assigned using total nutrient concentrations and turbidity levels.

Chlorophyll-a values are converted to a trophic state class assignment based on the mean period of record value for a given lake or wetland. The Trophic State Index Score of Carlson (1977) is used here to assign a lake to a given class. The four primary classes are Oligomesotrophic, Mesotrophic, Eutrophic, and Hypereutrophic. The Eutrophic class is further divided into three sub-classes, in order to better describe expected levels of use impairment. The hypereutrophic class is divided into two sub-classes for the same reason. In the case of the Hypereutrophic sub-classes, the dominance, or lack thereof, for blue-green algae (cyanophytes) also factors into use support assignments. Two other trophic state classes are used for lake and wetland assignments. First, an Argillotrophic waterbody is one that is nutrient rich but chronically light limited, resulting in artificially low algal biomass and chlorophyll-a. Second, a Dystrophic waterbody is one highly colored by humic/organic dissolved matter, which results in potentially lower than expected chlorophyll-a. There are some Argillotrophic lakes in Kansas, but Dystrophic lakes in Kansas are rare. **Table 24** presents lake trophic state designations for this reporting cycle.

Table 24. Trophic status of lakes during this reporting cycle

Trophic status	TSI	Number of Lakes (number and percent total)		Lake Surface Area (acres and percent total)	
Oligomesotrophic	< 40	14	4.42	407	0.21
Mesotrophic	40 – 40.99	36	11.36	12,228	6.39
Slightly Eutrophic	50 – 54.99	46	14.51	35,502	18.56
Fully Eutrophic	55 – 59.99	69	21.77	80,897	42.29
Very Eutrophic	60 – 63.99	45	14.20	23,866	12.48
Hypereutrophic	> 63.99	91	28.71	3,842	2.01
Argillotrophic		10	3.15	34,053	17.80
Dystrophic		0	0	0	0
Unknown		6	1.89	509	0.27
Totals		*317*	*~100.0*	*191,304*	*~100.0*

Trophic State Index (TSI) is based on chlorophyll levels and derived from Carlson (1977)

The greatest portion of individual lakes fell into the slightly-to-fully eutrophic and the hypereutrophic classes, while the greatest amount of surface acres were within the slightly-to-fully eutrophic and the argillotrophic classes. This difference primarily results from the skewed size range for Kansas lakes. The vast majority of lakes are smaller (and often shallower) systems, which may be more impacted by pollution sources (on a watershed acre-to-lake acre basis) than larger systems might be. Also, several of the larger federal lakes in Kansas are located on rivers that tend to move a great deal of eroded sediment. Therefore, several of the largest lakes in Kansas are chronically turbid and assigned to the argillotrophic class.

While roughly 2% of lakes reported for this cycle lack data for assigning a trophic state class, they comprise <1% of the total reported acres. The majority of these lakes are frequently dry systems, making long-term trophic classification problematic. As of 2011, all lakes and wetlands listed in the Kansas Surface Water Register have had use attainability analyses (UAAs) completed for all possible designated uses.

TRENDS IN LAKES

Time trends in lake water quality in Kansas are difficult to determine for individual lakes, due to the programmatic emphasis on regional and statewide assessment rather than in-depth studies at specific waterbodies. Trophic state remains the best means to examine trends in overall lake water quality, much as trophic state was earlier identified as a good overall water quality indicator for our lakes. Trends indicated in **Table 25** are general in nature. If a lake had three or more trophic state assessments over the years, a trend was assigned by the following protocol:

If there was a strong upward direction in trophic state over time, the lake was assigned to the "degrading" category. If there was a strong downward direction in trophic state over time, the lake was assigned to the "improving" category. Lakes were assigned to the "stable" category for two different sets of conditions. First, if trophic state assessments did not change much with time or, second, if they varied to the extent that any obvious trend was masked. Otherwise, lakes were assigned to the "unknown" category if they had no data available, or if they had fewer than three trophic state assessments over the period of record.

The largest portion of lakes in Kansas, for both numbers and surface acres, fell into the stable trend category. A significant number of lakes still fell into the unknown category, but they only comprise about 3% of total surface acreage.

Table 25. Trophic state trends in lakes

Category	Number of Lakes		Surface Area of Lakes	
	Count	% Total	Acres	% Total
Assessed for Trends	317	~100.00	191,304	~100.00
Improving	18	5.68	7,545	3.94
Stable	150	47.32	135,686	70.93
Degrading	41	12.93	42,549	22.24
Trend Unknown	108	34.07	5,524	2.89

CONTROL METHODS

Control methods for preventing or reversing pollution problems in Kansas lakes, as provided by KDHE, are primarily limited to the provision of technical advice and limited technical support, Section 319 grants aimed at citizen education and watershed best management practice (BMP) implementation, or guidelines for constructing or managing water supply lakes.

The KDHE Bureau of Environmental Field Services (BEFS) has operated a technical assistance program for taste and odor problems in water supply lakes since 1989. About 180 specific investigations have been undertaken as of 2011, dealing with water supply taste and odor problems, algae bloom concerns, fish kills, and other nuisance and public health concerns. Most such investigations are aimed at providing taxonomic assistance to water suppliers and lake managers. As of 2010, KDHE adopted a policy formalizing the response to algae bloom complaints and investigations as regards public health. Since 2010, approximately 45 lakes have been investigated for algae bloom related complaints; see Public Health section later in this report.

In-depth lake sampling and restoration projects at specific lakes in the past were dependent on the Section 314 Clean Lakes Program grants. With those roles now being transferred to Section 319 Nonpoint Source programs, in-depth lake assessment projects and restoration projects have been reduced in scope if not number. In the past, matching effort from the many smaller communities in Kansas was a constant problem for Clean Lakes Program projects. This problem is, if anything, more pronounced today.

The BEFS does maintain a statewide monitoring program for lakes and wetlands for the purposes of making statewide and regional assessments of overall lake water quality in Kansas. This network operates in order to comply with federal requirements and expectations under the Clean Water Act as well as serve state and local needs for information and technical assistance. This network has been in place since 1975, with wetlands first added in 1988. The network strives to provide a near-census for publicly owned/managed lake surface acreage in the state. The water quality data collected to date has been used to develop numerous water quality models that serve as valuable lake management tools, develop numerous TMDLs, and provide a basis for determining statewide water quality conditions and trends.

The Kansas Department of Wildlife, Parks and Tourism (KDWPT) provides assistance and technical advice to lake managers and citizens, with the emphasis on fisheries management rather than overall lake water quality. Some practices, such as the use of grass carp (*Ctenopharyngodon idella*) for plant control, or aeration/destratification, often run counter to maintaining the overall water quality within lakes.

RESTORATION AND REHABILITATION EFFORTS

Several restoration techniques have been applied in Kansas, but most instances are not documented in a fashion that makes such information readily available. Therefore, only restoration actions specific to projects directly involving KDHE, or higher profile projects primarily involved with other agencies, are discussed within this report. Some of the most common activities, perhaps dubiously referred to as rehabilitation techniques by many, involve the use of copper sulphate for algae control and grass carp for macrophyte control.

Although such activities are sometimes warranted, KDHE has tended to discourage the use of either practice as a prophylactic treatment. Copper sulphate should only be used for algae control if monitoring does show a strong need, and amounts should be applied with the full knowledge that copper will accumulate in the sediments. Grass carp, due to their impact on trophic state and water quality, should not be used for macrophyte control unless aquatic plants produce lake-wide problems to lake users and no other option is feasible. Fortunately, there are now available at least two aquatic herbicides registered for use in Kansas with selective control capabilities for Eurasian watermilfoil (*Myriophyllum spicatum*) and other dicotyledonous aquatic species. As Eurasian watermilfoil continues to expand into lakes throughout Kansas, the use of these new herbicides (fluridone and triclopyr) may supplant grass carp as the preferred plant control technique. As of 2011, roughly 15-20% of monitoring network lakes have Eurasian watermilfoil present at varying levels of abundance. As stated elsewhere, the lack of macrophyte beds is a far more common problem for maintaining healthy lakes in Kansas, rather than lakes with excessive macrophyte growth. Therefore, any technique that might allow native macrophyte species to be maintained or encouraged, while dealing with more invasive species, is welcome.

KDWPT is involved in lake restoration and rehabilitation for the primary purpose of fisheries management for recreation. Techniques, such as the recycling of brush and Christmas trees for fish habitat, are also common. Water level fluctuations are utilized for management of both fish spawning habitat as well as waterfowl management. KDWPT annually submits water level adjustment plans for many of the federal lakes in Kansas to the Kansas Water Office, which are reviewed and commented on at public meetings prior to submission to the US Army Corps of Engineers.

Aeration has become a common technique applied to smaller Kansas lakes in the attempt to control eutrophication. Unfortunately, almost all these efforts are undertaken without adequate study to determine whether aeration or destratification will positively impact lake water quality. Likewise, follow-up monitoring is typically limited to anecdotally observing a neutral-to-negative impact, followed by abandonment of the technique, or similarly observing a neutral-to-positive impact and continuing the technique into the future, whether or not it has had any measurable impact that could be definitively attributed to the technique. KDHE has strongly recommended to lake managers that aerators only be purchased and applied once a lake study has definitively shown aeration might improve water quality, versus other techniques.

The application of what are commonly referred to as "best management practices" continues to be the most common and useful means of lake restoration and rehabilitation in Kansas. This term can encompass a wide range of practices, for both agricultural and urban lands. Some of the more common techniques include vegetated buffer strips along streams and shorelines, diversions of runoff, pre-treatment impoundments, improved cropping/fertilization practices, sediment retention ponds, and treatment wetlands. Most BMP installation is via the Natural Resource Conservation Service (NRCS) and local Conservation Districts, in cooperation with KDHE, KDA-DOC, and/or the Kansas Water Office.

Wastewater National Pollutant Discharge Elimination System (NPDES) and confined animal feeding operation (CAFO) permits are sometimes used as a means to promote lake water quality restoration for Kansas lakes. Downstream impacts from such permitted facilities can be taken into account in the permitting process, and during public participation activities for such permits, regarding their limits on specific water quality parameters in effluents.

Dredging has also been an infrequent, and expensive, means to attempt to restore smaller lakes in Kansas. Dredging projects, due to the expense, have been few in number over the years. Such efforts have been even more infrequent since the Section 314 Clean Lakes Program ceased funding Phase 2 project grants through the Section 314 program specifically. Since these grants ceased to be funded in the 1990s, KDHE personnel have had direct knowledge of only two recent dredging projects in the state (Plainville Lake, in Rooks County, and Mission Lake, in Brown County).

During the period when Clean Lakes Program funds were available for in-depth diagnostic studies at specific lakes, or for restoration projects, a total of nine lakes had watershed restoration techniques recommended and implemented as part of Phase 1 grants. These lakes total 1,367 acres and are as follows: Ford County Lake (Ford County), Sabetha City Lake and Nemaha County State Fishing Lake (Nemaha County), Lake Afton (Sedgwick County), Olathe Lake (Johnson County), Chanute Santa Fe Lake (Neosho County), Herington Reservoir (Dickinson County), Rimrock Lake (Riley County), and Mary's Lake (Douglas County). In addition, a total of two lakes were dredged as part of Phase 2 grants under the Clean Lakes Program. These included Ford County Lake (Ford County) and Lone Star Lake (Douglas County). They comprise 243 acres.

Since the transfer of lake protection and restoration grants to the Section 319 Nonpoint Source Pollution Program, watershed land treatment has become emphasized over in-lake restoration at the state funding level.

ACID EFFECTS ON LAKES

A total of 190,897 acres of lakes in Kansas were either monitored or evaluated for pH, accounting for 99.8% of the total reported acres for this report cycle. Water quality impacts in Kansas resulting from pH levels, as seen in the data presented in **Table 21**, are almost totally due to higher pH values attained when lakes are over-enriched with nutrients and suffer from eutrophication and a high trophic state. For this report cycle, only two lakes had a pH below 6.5 units.

Even for the Mined Land Lakes Recreation Area units, where past coal mining makes them "likely" sites for low pH problems, such problems are few and far between. Enough time has passed since these areas were actively mined, and many have also been sporadically treated with lime additions, so that low pH problems are almost non-existent. Anecdotal evidence, from conversations with some citizens in southeast Kansas, suggests maybe a number of privately owned strip pit lakes still have chronically low pH, but KDHE has no specific data to confirm this. As most of the private strip pit lakes are as old as the public units, it is anticipated that the majority of them also show moderation of their pH ranges as they have aged.

The lack of an extensive Kansas problem with acidification stems from our regional geology. Kansas is underlain with abundant limestone bedrock, and soils derived from that limestone. Therefore, our state has a built in defense against atmospheric deposition of acid materials, or most other sources of acidic conditions. Other than the always possible, yet localized, chance of a spill of acidic material, the only significant sources for such water quality problems lie in past coal mined areas, or shale quarries, in Kansas. As shown by the pH data KDHE has collected throughout this region of southeast Kansas, such problems are mild and infrequent today.

Wetlands Assessment

EXTENT OF WETLAND RESOURCES

The wetland area reported for this 305(b) cycle is 55,969 acres. This includes all state and federal public wetland areas in Kansas, plus several that are owned or managed at the local level. This total does not include privately owned wetland areas, which likely comprise a larger total surface area in the state.

At present, Kansas does not have the data for a precise estimate of wetland loss from historic levels or for the current wetland area extant in the state. Several studies have been conducted in the past, but many have assumptions, based on their primary study purpose, that render them less useful for providing numbers related to total wetlands in Kansas. One of the better studies was that of Dahl (1990), which suggested that by the 1980s the conterminous United States had lost roughly 53% of its wetlands while Kansas had lost 48%. This suggests that our wetland loss is similar to the general estimates for the United States at about 2% per year.

The Dahl study (1990) suggested that historical wetland area in Kansas was around 841,000 acres total. A study by the United States Fish and Wildlife Service (USFWS) (WRAP, 1992) also suggested that total wetland area in Kansas, as of the 1980s, totaled around 435,400 acres, which is fairly consistent with estimated losses from historic levels from the Dahl study. Applying the 2% per year general loss rate to the USFWS value, perhaps 225,000 to 275,000 acres of wetlands still exist in Kansas. If accurate, the majority of extant wetlands in Kansas are on private lands.

While no estimates are available that differentiate the wetlands in Kansas among various wetland types, field observations suggest the majority of Kansas wetlands are palustrine freshwater marshes, palustrine saltwater (oligohaline) marshes, riparian wetlands, playas, and wet meadows.

INTEGRITY OF WETLAND RESOURCES

Out of the 55,969 wetland acres (36 wetlands) assessed during this reporting cycle, 45,066 acres (8 wetlands) are considered to be monitored sites. This represents 81% of the reported acreage. An additional 10,903 acres are reported as evaluated (28 wetlands, 78% of the total 36).

Wetlands in Kansas have all had "use attainability analyses" (UAAs) for the range of designated uses, but the primary functions of wetlands in Kansas are as aquatic life support and recreational sites. Therefore, only those specific individual uses are actually reported in **Table 26.** A total of 9,082 acres were assigned to the unknown category due to insufficient data. In most cases, "insufficient water quality data" resulted from the intermittent nature of standing water in wetlands (regarding both availability and depth) from which representative water samples might be collected.

Table 26. Individual use summary for wetlands (in acres)

Goals	Use	Size Assessed	Fully Supporting	Full Support But Threatened	Partially Supporting	Non Supporting	Insufficient Data
Protect and Enhance Ecosystems	Aquatic Life (acute criteria)	55,969	103	0	6,035	40,749	9,082
Protect and Enhance Public Health +	Fish Consumption ++	55,969	46,887	0	0	0	9,082
	Secondary Contact	55,969	104	0	6,034	40,749	9,082

+ = Shellfishing use cagetory not applicable and thus not reported
++ = Based on food procurement criteria for water

The primary causes of wetland use impairment for this 305(b) cycle are over-enrichment and extreme trophic state conditions, high turbidity, high pH levels, and hydrologic modifications and drought. **Table 27** presents data on the causes of use impairment in wetlands.

The major sources of wetland use impairment are agricultural runoff, hydrologic modifications and drought, and natural processes. **Table 28** presents data on the sources of use impairment in Kansas wetlands. Natural sources are primarily referring to climate and weather driven impacts (such as water depletion), naturally high salinity in some locales, or fluoride impacts. Natural sources account for virtually none of the nutrient/eutrophication or heavy metal related impacts in Kansas wetlands.

Table 27. Total wetland acres impacted by various cause categories

Cause Category (and code)	Acres by contribution to impairment	
	Major	Moderate/Minor
Cause Unknown (247)	0	0
Pesticides (148) [atrazine]	0	3,295
Heavy Metals (145) [arsenic]	0	1,265
Fluoride (555)	0	8,800
Nutrients and Eutrophication (483 and 746)	37,504	9,282
High pH (620)	0	22,000
Low pH (I678)	0	0
Siltation and Turbidity (995)	5,627	28,414
Chloride (272)	13,200	10,065
Sulfate (1016)	0	1,265
Flow Alterations (546)	1	13,933

During this reporting cycle, 41,845 acres of wetlands were assessed as hypereutrophic (74.8% of the total). In many cases, the degree of hypertrophy was extreme. Certainly, the level of nutrient enrichment was far above the expectations for wetland water quality in relatively low-impact drainages (i.e., "least-impacted" or better) (KDHE, 2002). These numbers indicate that the vast majority of the remaining Kansas wetlands under public control and management suffer an inordinately high degree of impact from nutrient enrichment and eutrophication.

Table 28. Total wetland acres impacted by various source categories

Source Category	Contribution to impairment	
	Major	Moderate/Minor
Municipal Point Sources (3)	4,572	13,934
Agriculture (18)	1,555	44,141
Urban (64)	70	20
Resource Extraction (252)	0	220
Hydromodification (1)	0	36,009
Natural Sources + (12 and 142)	0	23,001
Resuspension (205)	0	1,055
Unknown (496)	0	0

\+ Refers mainly to climate and drought impacts plus background levels of salinity and fluoride.

This current situation has led to the erroneous general impression that wetlands in Kansas are, as a matter of course, possessed of poorer water quality and extreme trophic state conditions. While wetlands would be expected, on average, to have higher nutrients and trophic status than comparable lakes, least impacted condition for wetlands is only marginally higher than least impacted condition for lakes. **Table 29** and **Table 30** present data on wetland trophic status and gross trophic state trends for this 305(b) cycle, respectively.

Table 29. Trophic status in wetlands

Trophic status	Number of wetlands		Acreage of wetlands	
	Count	Percent of total	Acres	Percent of total
Argillotrophic	0	0.00	0	0.00
Oligomesotrophic	2	5.56	40	0.07
Mesotrophic	1	2.78	1	<0.00
Slightly Eutrophic	0	0.00	0	0.00
Eutrophic	4	11.11	4,635	8.28
Very Eutrophic	3	8.33	366	0.65
Hypereutrophic	12	33.33	41,845	74.76
Dystrophic	0	0.00	0	0.00
Unknown	14	38.89	9,082	16.23
Totals	*36*	*~100.0*	*55,969*	*~100.0*

Table 30. Trophic state trends in wetlands

Category	Number of wetlands		Acreage of wetlands	
	Count	Percent of total	Count	Percent of total
Improving	1	2.78	1,055	1.88
Stable	15	41.67	44,151	78.88
Degrading	3	8.33	1,311	2.34
Trend Unknown	17	47.22	9,452	16.89
Assessed for Trends	36	~100.0	55,969	~100.0

DEVELOPMENT OF WETLAND WATER QUALITY STANDARDS

Wetlands are currently classified as "waters of the state" within the Kansas surface water quality standards (KDHE, 2005). UAA analyses have been completed for all designated uses, and the results of these UAAs are incorporated into the Kansas surface water register. Wetlands receive equal treatment and protection with lakes, regarding application of state water quality standards for narrative and numeric criteria, antidegradation provisions, and implementation procedures. The USEPA has proposed wetland specific biocriteria, but the development of such biocriteria is not felt feasible at this point in time.

ADDITIONAL WETLAND PROTECTION ACTIVITIES

Wetland protection tends to be distributed among agencies in Kansas, with no agency having a primary function for all aspects of wetland management. Kansas Department of Health & Environment (KDHE), Kansas Department of Wildlife, Parks and Tourism (KDWPT), the Kansas Department of Agriculture (KDA), Kansas Water Office (KWO), as well as the federal Army Corps of Engineers (ACOE) all have involvement in wetland protection and regulation. Kansas statutes (K.S.A. 82a-325 *et seq.*) require a total of eight state agencies, including KDHE, to review proposed water development projects for "beneficial and adverse environmental effects."

Persons desiring to alter regulatory wetlands in Kansas must file for Section 404 "dredge and fill" permits with the ACOE. Simultaneously, such permit requests come to KDHE for a Section 401 water quality certification. The department makes a determination of the projected impact on water quality resulting from the proposed action and may approve the action, approve it with modifications, or deny the action based on these projected water quality impacts.

One recent activity within KDHE has been the description of what are generally referred to as "reference" conditions for lakes and wetlands in Kansas. In essence, reference water quality conditions for lakes and wetlands occur in watersheds with none-to-limited levels of human activity and anthropogenic pollution loads. These "least impacted or better" waterbodies then describe the condition that would be generally attainable if polluting activities were reduced, well buffered, or otherwise mitigated in the general population of lakes and wetlands. Thus, reference condition provides a valuable and attainable water quality goal for a given class of waterbodies.

Based on the water quality and trophic state data collected since the 1970s for lakes and wetlands in Kansas, the following general conclusions regarding reference conditions have been reached. Lakes in Kansas with minimal pollution loads can be expected to achieve mesotrophic-to-slightly eutrophic conditions, with low total nutrient concentrations and relatively high water clarity (Dodds *et al*., 2006; Carney, 2009). Wetlands with similar minimal pollutant loads could be expected to achieve a trophic state in the low-to-mid range of eutrophic (chlorophyll-a at or under 12-to-18 ug/L), with low-to-moderate total nutrient levels (total phosphorus at or under 50-to-80 ug/L) (KDHE, 2002). For this 305(b) cycle, about 19.5% of assessed wetlands achieve "least impacted or better" status for nutrient levels and trophic state condition (8.35% of assessed surface area). As stated earlier in this report section roughly 75% of wetland acres exceed this least impacted or better threshold by a sizeable margin, suggesting public wetlands in Kansas are at high risk from nutrient pollution and eutrophication.

II. 303(D) ASSESSMENT RESULTS

The Kansas 2012 303(d) list identifies 524 station/pollutant combinations of water quality impairment on lakes, wetlands and stream systems (watersheds), encompassing 2,610 stream segments, and needing the development of TMDLs to address the offending pollutants.

The 2012 list also identifies 403 station/pollutant combinations of waters that were previously cited as impaired in prior lists but now are meeting water quality standards;117 of these are new in 2012.

The complete list is included in the printed version of the integrated report submitted to EPA (**Appendix B**). This list also can be accessed by the public via the internet at http://www.kdheks.gov/tmdl/methodology.htm.

Public Health Issues

I. DRINKING WATER USE

Use of surface waters in Kansas for drinking water supply (both public and domestic) is first determined through Use Attainability Analyses (UAAs). The domestic water supply use can be either existing or attainable; therefore, the UAA process examines the likely hydrology and ambient water quality to determine attainability. Existing drinking water supply use can be verified by inspection of water rights from the Division of Water Resources of the Kansas Department of Agriculture. Attainable use is assigned to perennial streams that exhibit parameter concentrations (chloride, sulfate, fluoride, total dissolved solids) that are less than twice applicable criteria or guidance. As a result of this screening, most streams in the central and eastern portions of Kansas could potentially support drinking water uses. Similarly, lakes are assessed and, more often than not, found to support attainable drinking water supply uses.

Currently, 19,996 stream miles (71% of the Kansas Surface Water Register) and 189,524 acres of lakes bear the designated use for Domestic Water Supply. However, assessment of the support for this use is complicated by the provisions of the Kansas Surface Water Quality Standards. Application of water quality criteria protective of drinking water is to occur at "the point of domestic water supply diversion." Therefore, true assessment is focused on support of existing uses. Furthermore, the domestic water supply use is defined as the production of potable water, after appropriate treatment. The ambient quality of the surface water should not confound the routine treatment of the raw water supply into potable water for human consumption. However, assessment of support of the drinking water use under 303(d) is chiefly directed at the potential, attainable use of that water at some unspecified future time.

Assessing support of the water quality criteria underlying the drinking water use involves evaluating monitoring data for too frequent excursions from applicable numeric criteria, such as nitrate, sulfate, chloride, arsenic or fluoride. In cases of elevated nitrate, the root cause has typically been wastewater with insufficient denitrification. Such situations call for the water to be classed Category 5 with a TMDL scheduled for development.

Impairments due to chloride, sulfate, arsenic and fluoride are often contributed by natural, geologic sources, sometimes exacerbated by water use and reuse, concentrating salts through water loss induced by evapo-transpiration. To the degree possible, background concentrations are established as part of the water quality standards that reflect natural contributions that exceed the existing criteria for those pollutants, are not influenced by flow alterations or diversions and leave the surface water usable under the definition of domestic water supply use.

Impairment from excessive nutrients is assessed relative to trophic conditions in lakes that present problems to aquatic life, recreation and drinking water. Endpoints used by eutrophication TMDLs are set at level that should assure full attainment of all three of these designated uses. Similarly, screening for excess phosphorus in streams result in adaptive TMDLs that continue to reduce loadings of phosphorus from point and non-point sources until such time that blue-green algae counts and complaints of taste and odor in drinking water are minimized.

II. BEACH USE

Eutrophication, the enrichment of waterbodies with excess nutrients and the nuisance algal growth that results, causes many impacts to water quality and to the beneficial uses we expect our lakes and streams to provide us. Impacts can range from disrupting ecological system integrity, to reducing revenues from recreational use, to increasing costs and risks related to providing drinking water (Dodds *et al*., 2009). Perhaps the most noticeable impact to the general public is the generation of large population explosions of phytoplankton that are generally called "blooms." These algae blooms are the net result of over-enrichment of lakes with plant nutrients (primarily phosphorus, but also nitrogen). Blooms can occur suddenly, and at all times of the year, and can be composed of numerous species from various taxonomic groups. However, the most common blooms, and certainly of the most concern to public health, are blooms composed of blue-green algae (cyanophytes).

Blue-green algae are actually large, free-living, photosynthetic bacteria. They are a natural part of the ecology, usually occurring in fairly small numbers, only becoming a problem when they grow to extreme populations. They are lumped under the functional term "algae" with other organisms because they share many of the same habitat requirements as these other types of algae (green algae, diatoms, euglenoids, dinoflagellates, etc.). A blue-green algae bloom can be extremely large, numbering in the millions of cells per milliliter of water. Such blooms create conditions that are visually objectionable to the public, produce foul odors, obstruct boats and other forms of recreation, cause taste and odor problems in finished drinking water, and cause fishkills. Most blue-green algae blooms will occur in nutrient enriched lakes during the summer, when water temperatures are highest, but a few species prefer cooler temperatures. Although they produce sufficient aesthetic problems to impair many recreational and economic activities, their ability to produce toxic compounds makes them a threat to public health as well.

Blue-green algae are capable of producing a number of different biochemical compounds that are toxic to warm blooded organisms (for the most part). These compounds fall into three general categories: hepatotoxins (which primarily affect the liver and other internal organs), neurotoxins (which primarily impact the nervous system), and dermatotoxins (which affect the skin, mucus membranes, eyes, ears, and throat). Over 200 different algal toxins have been identified in freshwaters (where blue-green algae are the most common toxic species) and in marine environments (where dinoflagellates tend to be the most common type of toxic algae). In the Midwest, microcystins (a type of hepatotoxin) are the most commonly documented algal toxin (Graham *et al*., 2010), although other toxins (such as the neurotoxic anatoxin-a and saxitoxin) do occur at a lesser frequency. There are almost 100 identified variants of the microcystin toxin known. Some of these algal toxins rival, or exceed, the potency of cobra venom.

Over two-dozen genera of blue-green algae may be found in the waters of Kansas, but the majority of blooms and complaints are attributable to five genera. All are colonial forms, forming filaments or large globs of cells that look like green cottage cheese floating in the water. These include *Microcystis spp.* (species can produce the hepatotoxin microcystin), *Anabaena spp.* (species can produce both hepatotoxins and neurotoxins), *Aphanizomenon spp.* (species can produce neurotoxins), *Planktothrix spp.* (species can produce both neurotoxins and the hepatotoxin microcystin), and *Cylindrospermopsis raciborskii* (can produce the hepatotoxin cylindrospermopsin). Essentially all species of blue-green algae produce dermatotoxins that are associated with their cell walls. Most blue-green algae have optimal growth at higher ambient temperatures (>27^{o} C), but some species, such as *Planktothrix rubescens* seem to grow quite well in the middle of winter, often forming reddish masses of algae under ice layers.

Around the world, pets, livestock, wildlife, and people have been made ill or died after exposure to blue-green blooms and their toxins, including Kansas. Exposure to algal toxins is primarily through the ingestion of water containing blue-green algae, but exposure can also occur through breathing aerosols or through skin contact. Because of the increase in lakes and streams suffering from nutrient enrichment and eutrophication, problems related to blue-green algae and their blooms have also increased dramatically over the last few decades. Many U.S. states, and a number of foreign countries, have adopted formal programs and protocols for dealing with the public health threat posed by excessive blue-green algae in our waters. Kansas joined those other entities two years ago by adopting a formal response policy on August 13, 2010.

The program adopted by the Kansas Department of Health and Environment is a joint effort among several Bureaus within both Divisions (Health and Environment) of the agency. It is complaint driven, with citizens, lake managers, or other officials able to access and submit a form online (www.kdheks.gov/algae-illness/index.htm). Once submitted, the complaint is vetted, and appropriate sampling of the waterbody is conducted. Sampling is directed towards the major points of public access onto the water (marinas, swimming beaches, main boat ramps or dock facilities, etc.), and continues until algal cell counts and toxin levels decline to safe thresholds. The program is limited to publicly owned or managed waterbodies. To date 42 lakes have been sampled under this program. The primary purposes of the program are to inform the public of health risks associated with the current condition of the lake, to advise lake managers as to what course of action is most appropriate, and supply technical expertise to those lake managers. Two levels of threat are recognized under the program: "watch" (20,000-100,000 blue-green cells/mL where the existing conditions could quickly become a threat to health and safety) and "warning" (>100,000 blue-green cells/mL where conditions are believed to represent a threat to health and safety) (Chorus *et al.,* 1999).

III. FISH CONSUMPTION

Public health concerns related to the consumption of locally caught fish are addressed in the 2012 fish advisories. These advisories are available on the KDHE website at http://www.kdheks.gov/news/web_archives/2012/01052012b.htm and also printed in the 2012 Fishing Atlas (KDWPT, 2012). Harmful algae blooms are also mentioned in the advisory as they relate to fish consumption.

IV. OTHER CONSIDERATIONS

In addition to routine and proactive surface water monitoring, KDHE also provides immediate response to events that may affect or reflect surface and ground water quality. One of these is the Spills Program, administered by the Bureau of Environmental Remediation and operated in conjunction with the Kansas Corporation Commission (for spills on oil leases). The Spills Program is authorized by Kansas law (KSA 65-171d and KaR 28-48) and is used to address events that can be quickly resolved with the goal of preventing long term harm to our soil or water resources. If a spill or release impacts ground water, it may be referred to a remedial program to address the problem, but sometimes the spiller is successful in isolating ground water impacts and can remediate it immediately through the spills program. **Table 31** presents a brief summary of events investigated and resolved by the KDHE spills program in 2010-2011. It does not include spills overseen or investigated by KCC.

Table 31. Summary of 2010-2011 spill events

	2010	2011
KDHE purview: surface water impacted	94	84
with fishkill events	*2*	*0*
KDHE purview: Ground water impacted	10	5
with referral to long-term remediation	*2*	*3*

This includes events that affected surface or ground water and were investigated or tracked by the KDHE Spills Response program. It does not include spill events related to oil leases, which are tracked by the KCC.

Another such program is the Fishkill Response program, administered through the Bureau of Environmental Field Services and coordinated with colleagues from the Kansas Department of Wildlife, Parks, and Tourism. In 2008-11, KDHE responded to 23 fishkill events. These were investigated and resolved, and a brief summary is presented in **Table 32.**

Table 32. Summary of fishkill events investigated by KDHE 2008-2011

Waterbody Type	Cause	YEAR				Grand Total
		2008	2009	2010	2011	
Lake/Pond	Organic loading	9	1	1	2	13
	Unknown		1			1
Lake/Pond Total		*9*	*2*	*1*	*2*	*14*
River/Stream	Organic loading	5	4	4	1	14
	Toxics	1	1	2		4
	Other causes	2	1			3
	Unknown		2	1	2	5
River/Stream Total		*8*	*8*	*7*	*3*	*26*
Grand Total		*17*	*10*	*8*	*5*	*40*

PART D. GROUND WATER MONITORING AND ASSESSMENT

Overview

Kansas no longer maintains a statewide groundwater quality monitoring program, and funding for the renewal of such an enterprise appears unlikely in the near future. However, an earlier monitoring program (suspended in 2002 owing to budgetary constraints) routinely evaluated groundwater quality at more than 200 sites in Kansas. Individual wells in the monitoring network were sampled on a two-year rotational basis, with approximately half the wells being sampled in any given year. All wells in the network adhered to specific siting, depth, and construction criteria, and the network as a whole was deemed representative of the state's major aquifer systems. The program's surviving electronic database contains roughly 150,000 records spanning 120 different physical, chemical, and radiological parameters and 327 groundwater quality monitoring locations. Additional background information is presented in the program's QAPP and accompanying set of SOPs, last revised in December 2000 (KDHE, 2000; http://www.kdheks.gov/environment/qmp_2000/download/2007/GQMP_QAMP.pdf).

Some groundwater quality information continues to be gathered by KDHE through the efforts of its major regulatory bureaus; see **Table 33** for an overview of state groundwater protection program. The Bureau of Environmental Remediation routinely samples groundwater from the vicinity of groundwater remedial sites, storage tank cleanup sites, and a few active surface mining operations. The Bureau of Waste Management obtains groundwater quality information from nearly 200 landfills (both closed and active) as well as hazardous waste sites across the state. BOW requires a number of major NPDES permit holders to periodically submit data on groundwater quality. Examples include large CAFOs, meat processing facilities, electrical power plants, and a few municipal WWTFs. Underground Hydrocarbon Storage well and brine storage pond permits also require submittal of data on groundwater quality. Monitoring activities generally focus on surficial groundwater and/or a very limited set of analytical parameters; see **Table 34** for a summary of major sources of groundwater contamination and **Table 35** for a statewide cumulative summary of groundwater contamination. These assorted monitoring operations are not intended to provide representative information on the state's major aquifer systems or to serve as a coordinated and comprehensive ambient groundwater quality monitoring program.

Groundwater monitoring related to Public Water Supply Systems is addressed separately in the next section, because of its direct impact on human health. Under the Safe Drinking Water Act, public water suppliers are required to submit data on the quality of their source water; in Kansas, a majority of which is groundwater. Additionally, Groundwater Management Districts and the Kansas Geologicla Survey monitor groundwater quality for management and research purposes.

Table 33. Summary of state groundwater protection programs

Programs or Activities	Check (X)	Implementation Status	Responsible State Agency or Principal Administrative Agency
Active SARA Title III program	X	fully established	KDHE*
Ambient groundwater monitoring		(suspended)	(KDHE)
Aquifer vulnerability assessment	X	on going	KDHE*
Aquifer mapping	X	fully established	KGS
Aquifer characterization	X	on going	KGS
Comprehensive data management	X	on going	KDHE
EPA-endorsed Core Comprehensive State Groundwater Protection Program	X	under review	KDHE
Groundwater discharge permits	X	fully established	KDHE
Groundwater Best Management Practices	X	fully established	KDHE
Interagency coordination for groundwater protection initiatives	X	on going	KWO
NPS controls	X	fully established	KDHE*
Pesticide State Management Plan	X	EPA approved plan implementation proceeding	KDA
Pollution Prevention Program	X	fully established	KDHE
RCRA Primacy	X	fully established	KDHE
Source Water Assessment Program (SWAP)	X	fully established	KDHE
State Water Plan Orphan Sites	X	fully established	KDHE
State RCRA with more stringent requirements than RCRA Primacy	X	fully established	KDHE
State septic system regulations	X	fully established	KDHE
Underground Storage Tank (UST) installation requirements	X	fully established	KDHE
UST Remediation Fund	X	fully established	KDHE
UST Permit Program	X	fully established	KDHE
Underground Hydrocarbon Storage Well Program	X	fully established	KDHE
Underground Injection Control Program	X	fully established	KCC & KDHE
Vulnerability assessment for drinking water/wellhead protection	X	EPA approved plan implementation proceeding	KDHE
Well abandonment regulations	X	fully established	KDHE & KCC
Wellhead Protection Program	X	approved plan implementation proceeding	KDHE
Well installation regulations	X	fully established	KDHE

KGS – Kansas Geological Survey KDA – Kansas Department of Agriculture
KCC = Kansas Corporation Commission KWO – Kansas Water Office

Table 34. Major sources of groundwater contamination

Ten Highest Priority Contaminant Sources	Factors Considered in Selecting a Contaminant Source	Types of Contaminants
Agricultural Activities:		
Chemical and grain facilities/applications	A, C, D	B, C, D, E
Animal feedlots	A, C, D, E	G, E, J
Storage and Treatment:		
Storage tanks (AST/LUST)	A, B,C, D	D
Surface impoundments	A, E	E, H
Disposal Activities:		
Landfills/illegal dumping	A, C,E	C, D, G, H
Other:		
Active/abandoned industrial facilities	A, B, C	B, C, D, E, G, H, I, M
Oil and gas activities	A, B,C,D	H, D, G, I
Pipelines and sewer lines	A, E	C, D, E
Salt water intrusion	B, C, D, E	G
Spills, trucking, rail	A, D	B, C, D, E, G, H

Factors Considered in Selecting a Contaminant Source:
(A) Human health and/or environmental risk (toxicity)
(B) Size of population at risk
(C) Location of sources relative to drinking water sources
(D) Number and/or size of contaminant sources
(E) Hydrogeologic sensitivity

Types of Contaminants:

(A) Inorganic pesticides	(F) Fluoride	(K) Protozoa
(B) Organic pesticides	(G) Salinity/brine	(L) Viruses
(C) Halogenated solvents	(H) Metals	(M) PCBs
(D) Petroleum compounds	(I) Radionuclides	
(E) Nitrate	(J) Bacteria	

Table 35. Groundwater contamination: statewide cumulative summary through December 31, 2011

Source Type	# of Kansas Sites	# of Sites with Confirmed Releases	# with Confirmed Groundwater Contamination	Primary Contaminants	# of Site Assess-ments	# of Sites with Source Removed	# of Sites with Corrective Action Plans	# of Sites with Active Remediation	# of Sites with Ongoing Monitoring	# of Sites with Cleanup Resolved
NPL	15	15	15	VOCs, metals	15	Unavail.	4	6	(6)	4
CERCLIS (non-NPL)	87	87	12	VOCs, metals & PCBs	87	Unavail.	1	2		57
DOD/FUDS	422	422	110	VOCs, metals, refined petroleum	422	Unavail.	Unavail.	23		67
LUST	10,474	5,014	4,272	gasoline and diesel fuels	10,474	Unavail.	N/A	180		9,087
RCRA Corrective Action (incl. 6 military sites)	45	45	45	VOCs, metals & semi-volatiles	44	10	21	21	34	9
Solid Waste Landfills	177	51	51	VOCs & metals	165	N/A	5	5	5	0
Underground Injection Wells +	32	0	0	-	0	0	0	0		N/A
Underground Hydrocarbon Storage Wells	10	0	0	-	0	0	0	0		N/A
Underground Hydrocarbon Storage Brine-Storage Ponds (Multiple ponds per site)	9	9	9	Brine	9	9	9	9	9	0
State Sites (not including LUST sites or KCC jurisdiction sites)	2,019	2,019	980	VOCs, metals, refined petroleum	2,019	Unavail	45	174		720

CERCLIS - Comprehensive Environmental Response, Compensation, and Liability Information System; Includes non-NPL Management Assistance (CERCLA Lead and Superfund sites)
DOD/FUDS - Department of Defense/Formerly Used Defense Sites
LUST - Leaking Underground Storage Tanks
NPL - National Priority List
NPS - Nonpoint Source
RCRA - Resource Conservation and Recovery Act
+ Represents Class I and III injection wells, but does not include Class II brine injection wells.

Groundwater Monitoring associated with Public Water Supply Systems

A Public Water Supply System (PWSS) entity may be composed of multiple facilities or components: groundwater wells, surface intakes, consecutive connections, treatment plants, storage tanks, and distribution systems. Normally, water flows from a raw source (or consecutive connection, if purchased from another entity) into a treatment plant, and then into the distribution system. Public water supply compliance monitoring is usually performed at the end of the treatment plant processes just prior to entry into the distribution system, or in the distribution system itself. Treated water samples do not necessarily reflect the unaltered state of the raw water that initially flows into the treatment plant.

Only a few compliance samples are collected at the raw water source, *i.e,*. groundwater wells and surface intakes. However, some raw water monitoring is performed under the aegis of Public Water Supply, and the results are reported here. Raw water sampling (whether from a groundwater or surface water source) is normally limited to just a few types of sampling:

1. (Compliance) Total organic carbon samples are collected from intakes to be used as part of the Disinfection By-Product rule determinations. The samples are matched up with a corresponding treatment plant sample so compliance can be determined.
2. (Compliance) Groundwater samples are collected as part of the Groundwater Rule, which requires source monitoring after a positive microbiological sample is collected in the distribution system. The goal is to determine whether a positive in the distribution system can be traced back to raw source water. In Kansas, since the inception of the GWR, few positive samples have been collected at a well after a distribution system positive.
3. (Non-Compliance) When an application is made for installation of a new public water supply well, plans are submitted, inspections are performed, and water quality test well kits are taken to provide baseline testing on a broad spectrum of inorganic, organic, radiological, and microbiological parameters. As a service to Public Water Supply Systems, KDHE offers special study sampling and test well kit monitoring to help identify the best sources of water. Test wells are drilled and water quality is determined before permits are issued. These samples are not used for compliance determinations, but are considered special study samples specifically for the permitting process.
4. (Non-Compliance) Special study samples are performed intermittently by systems for many different reasons. Normally these samples help systems identify or correct a problem for which they may or may not be aware. Often special studies are completed as part of an engineering firm's work when they are hired by the PWSS to make improvements or perform maintenance.

Table 36 presents results of 2006-2010 groundwater testing from both routine compliance monitoring samples and non-compliance special study sampling completed at water treatment plants and groundwater wells.

Table 36. Results of groundwater monitoring associated with Public Water Supply Systems, 2006-2010

Monitoring Data Type	Parameter / Group	Sources	Total Samples	Samples with No Detects	Samples with Detects	Detects Nitrate ≤ 5 mg/L	Nitrate >5 and ≤ 10 mg/L	Parameters Exceeding MCL	Compliance Violations
Untreated Water	VOC	70	445	357	88	--	--	14	--
	SOC	56	401	320	81	--	--	0	--
	EDB	57	409	406	3	--	--	0	--
	Arsenic	50	149	36	113	--	--	15	--
	Fluoride	49	150	9	141	--	--	4	--
	Mercury	45	143	142	1	--	--	0	--
	Nitrate	67	174	41	133	76	36	21	--
	Selenium	44	143	46	97	--	--	3	--
Finished Drinking Water	VOC	925	1690	531	159	--	--	10	4
	SOC	922	1541	1361	180	--	--	0	0
	EDB	925	1689	1676	13	--	--	1	0
	Arsenic	934	1705	336	1369	--	--	160	74
	Fluoride	936	2414	43	2371	--	--	30	17
	Mercury	933	1540	1536	4	--	--	1	0
	Nitrate	1065	6848	750	6097	4066	1526	505	257
	Selenium	934	1564	138	1426	--	--	14	5

This shows all detected parameters, whether they were measured for compliance or other purposes. Only the “Violations” column applies to actual compliance monitoring violations. Special studies or test well kit samples are never used to determine compliance or violations. Maximum Contaminant Level (MCL) for nitrate is 10.

PART E. PUBLIC PARTICIPATION

As required by federal regulation and the Kansas continuing planning process, the 2012 303(d) list and associated methodology were subjected to public review. Formal public notice of the list was made via the Kansas Register on February 23, 2012. This notice included a link to the KDHE TMDL website, from which interested parties wre able to review and download the entire 303(d) list and a detailed description of the listing methodology. KDHE held two public hearings regarding the list, one, in Topeka on February 29, 2012 at KDHE; the other on March 1, 2012 in Chanute at the KDHE District Office. Neither hearing was attended by the public, a typical situation for the Kansas 303(d) process, but agency staff was briefed on the development of the list by the TMDL program. The comment period was held open until March 23, 2012, but no letters or emails were forthcoming from the public commenting on aspects of the 2012 list.

Typically, KDHE uses the Basin Advisory Committees (BACs) from each of the targeted river basins as a forum to discuss the list. Unfortunately, this year, those BAC meetings conflicted with TMDL program schedules. The TMDL program produced a memorandum for each BAC outlining the new listings and delisted waters in their basin as well as the intended waters that will have TMDLs developed. The TMDL program is also scheduled to brief each BAC in the Marais des Cygnes, Missouri, Neosho, Walnut and Verdigris Basins this coming summer in order to confirm the priority selections of impaired waters slated to have TMDLs established over the next two years. A meeting with the Neosho BAC is scheduled for April 17, 2012 to discuss the listings and plans for the TMDLs in the basin in 2013.

The TMDL program also coordinated with KDHE's Watershed Management Section, in charge of the NPS 319 program, on which waters were being worked through individual WRAPS groups' watershed plans in the five basins slated for TMDL work in 2012 – 2014. Additionally, WRAPS needs for TMDLs as well as those preferred to be deferred were reflected in the priority setting process for TMDL establishment over the next two years. The TMDL program will brief each WRAPS that requests additional information on coordinating TMDL demands with watershed implementation.

Based on the proposed 2012 303(d) list, some 34 pollutant-watershed combinations in the Missouri, Marais des Cygnes, Neosho and Walnut basins are slated for TMDL development over 2012 – 2014. These selections may be altered after discussion with each basin's Basin Advisory Committee, changing priorities of the State environmental programs or contemporary issues (e.g. blue-green algae outbreak) at certain waters within the five basins in the upcoming cycle. Additionally, some revisit and revision of existing TMDLs in the basins may occur during the next cycle.

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APPENDIX A. ROUTINE AND SUPPLEMENTAL PARAMETERS

A1. Routine and supplemental water chemistry and related parameters analyzed by the Targeted Stream Chemistry Monitoring Program, the Lake and Wetland Program, and the Probabilistic Stream Monitoring Program. R = routine / s = supplemental / d = discontinued

TYPE	PARAMETER	Targeted Stream Chemistry Program	Probabilistic Stream Program	Lake and Wetland Program
Inorganic / Composite	Alkalinity, total (as CaCO3)	R	R	R
Inorganic / Composite	Aluminum, total recoverable	R	R	R
Inorganic / Composite	Ammonia, total (as N)	R	R	R
Inorganic / Composite	Antimony, total recoverable	R	R	R
Inorganic / Composite	Arsenic, total recoverable	R	R	R
Inorganic / Composite	Barium, total recoverable	R	R	R
Inorganic / Composite	Beryllium, total recoverable	R	R	R
Inorganic / Composite	Boron, total recoverable	R	R	R
Inorganic / Composite	Bromide	R	R	R
Inorganic / Composite	Cadmium, total recoverable	R	R	R
Inorganic / Composite	Calcium, total recoverable	R	R	R
Inorganic / Composite	Carbon, total inorganic (calculated)	.	.	R
Inorganic / Composite	Carbon, total organic	R	R	R
Inorganic / Composite	Chloride	R	R	R
Inorganic / Composite	Chromium, total recoverable	R	R	R
Inorganic / Composite	Cobalt, total recoverable	R	R	R
Inorganic / Composite	Conductivity (field)	R	.	.
Inorganic / Composite	Copper, total recoverable	R	R	R
Inorganic / Composite	Dissolved oxygen	R	R	R
Inorganic / Composite	Fluoride	R	R	R
Inorganic / Composite	Hardness, total (as CaCO3)	R	R	R
Inorganic / Composite	Iron, total recoverable	R	R	R
Inorganic / Composite	Kjeldahl nitrogen	R	R	R
Inorganic / Composite	Lead, total recoverable	R	R	R
Inorganic / Composite	Magnesium, total recoverable	R	R	R
Inorganic / Composite	Manganese, total recoverable	R	R	R
Inorganic / Composite	Mercury, total	R	R	R
Inorganic / Composite	Molybdenum, total recoverable	R	R	R
Inorganic / Composite	Nickel, total recoverable	R	R	R
Inorganic / Composite	Nitrate (as N)	R	R	R
Inorganic / Composite	Nitrite (as N)	R	R	R
Inorganic / Composite	pH	s	s	s
Inorganic / Composite	pH (field)	R	R	R
Inorganic / Composite	Phosphate, ortho- (as P)	R	R	R
Inorganic / Composite	Phosphorus, total (as P)	R	R	R

A1, Continued.

TYPE	PARAMETER	Targeted Stream Chemistry Program	Probabilistic Stream Program	Lake and Wetland Program
Inorganic / Composite	Potassium, total recoverable	R	R	R
Inorganic / Composite	Selenium, total recoverable	R	R	R
Inorganic / Composite	Silica, total recoverable	R	R	R
Inorganic / Composite	Silver, total recoverable	R	R	R
Inorganic / Composite	Sodium, total recoverable	R	R	R
Inorganic / Composite	Specific conductance	R	R	R
Inorganic / Composite	Strontium, total recoverable	R	R	R
Inorganic / Composite	Sulfate	R	R	R
Inorganic / Composite	Temperature	R	R	R
Inorganic / Composite	Temperature (field)	R	R	R
Inorganic / Composite	Thallium, total recoverable	R	R	R
Inorganic / Composite	Total dissolved solids (calculated)	R	R	R
Inorganic / Composite	Total suspended solids	R	R	R
Inorganic / Composite	Turbidity	R	R	R
Inorganic / Composite	Uranium, total recoverable	R	R	o
Inorganic / Composite	Vanadium, total recoverable	R	R	R
Inorganic / Composite	Zinc, total recoverable	R	R	R
microbiological	Escherichia coli (E. coli)	R	R	R
Organic	2,4,5-T as acid	d	d	d
Organic	2,4,5-TP as acid (Silvex)	d	d	d
Organic	2-4-D as acid	d	d	d
Organic	Acetochlor	R	R	R
Organic	Alachlor	R	R	R
Organic	Aldrin	R	R	R
Organic	Alpha BHC	R	R	R
Organic	Atrazine (Aatrex)	R	R	R
Organic	beta-BCH	R	R	R
Organic	Bromacil	s	s	.
Organic	Butachlor	R	R	R
Organic	Carbofuran (Furadan)	R	R	R
Organic	Chlordane	R	R	R
Organic	Chlorpyrifos (Dursban)	s	s	.
Organic	Cyanazine (Bladex)	R	R	R
Organic	DCPA (Dacthal)	R	R	R
Organic	Deethylatrazine	s	s	R
Organic	Deisoproplyatrazine	s	s	R
Organic	Delta BHC	R	R	R
Organic	Diazinon	s	s	.
Organic	Dieldrin	R	R	R
Organic	Endosulfan I	R	R	R
Organic	Endosulfan II	R	R	R
Organic	Endosulfan sulfate	R	R	R
Organic	Endrin	R	R	R

A1, Continued.

TYPE	PARAMETER	Targeted Stream Chemistry Program	Probabilistic Stream Program	Lake and Wetland Program
Organic	Gamma BHC (Lindane)	R	R	R
Organic	Heptachlor	R	R	R
Organic	Heptachlor epoxide	R	R	R
Organic	Hexachlorobenze	R	R	R
Organic	Hexachlorocyclopentadiene	R	R	R
Organic	Methoxychlor	R	R	R
Organic	Metolachlor (Dual)	R	R	R
Organic	Metribuzin (Sencor)	R	R	R
Organic	p,p’-DDD	R	R	R
Organic	p,p’-DDE	R	R	R
Organic	p,p’-DDT	R	R	R
Organic	PCB-1016	R	R	R
Organic	PCB-1221	R	R	R
Organic	PCB-1232	R	R	R
Organic	PCB-1242	R	R	R
Organic	PCB-1248	R	R	R
Organic	PCB-1254	R	R	R
Organic	PCB-1260	.	.	R
Organic	Pentachlorophenol	s	s	.
Organic	Picloram (Tordon)	d	d	d
Organic	Prometon (Pramitol)	s	s	.
Organic	Propachlor (Ramrod)	R	R	R
Organic	Propazine (Milogard)	R	R	R
Organic	Simazine	R	R	R
Organic	Toxaphene	R	R	R
Other	Algal taxonomy (field)*	.	R	R
Other	Chlorophyll-a	s	R	R
Other	Macrophyte abundance (field)*	.		R
Other	Phaeophytin-a	s	R	R
Other	Pheophytin-a	s	s	.
Other	Photosynthetically active radiation (PAR)*	.	.	R
Other	Secchi depth (field)*	.		R
Radiological	Actinium-228	s	.	.
Radiological	Americum-241	s	.	.
Radiological	Antimony-125	s	.	.
Radiological	Barium-140	s	.	.
Radiological	Beryllium-7	s	.	.
Radiological	Cerium-141	s	.	.
Radiological	Cerium-144	s	.	.
Radiological	Cesium-134	s	.	.

A1, Continued.

TYPE	PARAMETER	Targeted Stream Chemistry Program	Probabilistic Stream Program	Lake and Wetland Program
Radiological	Cesium-136	s	.	.
Radiological	Cesium-137	s	.	.
Radiological	Chromium-51	s	.	.
Radiological	Cobalt-57	s	.	.
Radiological	Cobalt-58	s	.	.
Radiological	Cobalt-60	s	.	.
Radiological	Gallium-67	s	.	.
Radiological	Gross alpha	s	.	.
Radiological	Gross beta	s	.	.
Radiological	Indium-111	s	.	.
Radiological	Iodine-123	s	.	.
Radiological	Iodine-131	s	.	.
Radiological	Iodine-132	s	.	.
Radiological	Iodine-133	s	.	.
Radiological	Iron-59	s	.	.
Radiological	Lanthanum-140	s	.	.
Radiological	Manganese-54	s	.	.
Radiological	Molybdenum-99	s	.	.
Radiological	Neodymium-147	s	.	.
Radiological	Neptunium-239	s	.	.
Radiological	Niobium-95	s	.	.
Radiological	Potassium-40	s	.	.
Radiological	Radium-226	s	.	.
Radiological	Ruthenium-103	s	.	.
Radiological	Ruthenium-106	s	.	.
Radiological	Technetium-99m	s	.	.
Radiological	Thorium-228	s	.	.
Radiological	Tritium	s	.	.
Radiological	Ytterbium-169	s	.	.
Radiological	Zinc-65	s	.	.
Radiological	Zirconium-95	s	.	.

A2. Routine fish tissue parameters analyzed by the EPA Region 7 laboratories for the Fish Tissue Contamination Monitoring Program. R = routine

Type	Core Inorganic Parameters	Fillet	Whole-fish
inorganic	Cadmium	R	R
inorganic	Lead	R	R
inorganic	Mercury	R	R
inorganic	Selenium	R	R
organic	1,2,4,5 -Tetrachlorobenzene	.	R
organic	p,p'-DDD	R	R
organic	p,p'-DDE	R	R
organic	p,p'-DDT	R	R
organic	Dieldrin	R	R
organic	Heptachlor	R	R
organic	Heptachlor epoxide	R	R
organic	Hexachlorobenzene	R	R
organic	gamma-Hexachlorocyclohexane (BHC)	R	R
organic	Mirex	.	R
organic	PCB-1248	R	R
organic	PCB-1254	R	R
organic	PCB-1260	R	R
organic	Pentachloroanisole	R	R
organic	Pentachlorobenzene	.	R
organic	Technical Chlordane	R	R
organic	Oxychlordane	R	.
organic	cis-Chlordanet	R	.
organic	trans-chlordane	R	.
organic	cis-Nonachlor	R	.
organic	trans-Nonachlor	R	.
organic	Trifluralin (Treflan)	R	R

APPENDIX B. 303(D) LIST.

Appendix B contains the most recently completed 303(d) list for the state of Kansas. The first 120 pages include lists of all impaired or potentially impaired waters, by basin. The next 34 pages include lists of all waters formerly listed, by basin.